Ontario Geological Survey

Report 186

Geology of the
Hewitt Lake Area

District of Kenora, Patricia Portion

By

John Wood

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GEOLOGICAL MAP

(back pocket)

Map 2408 (coloured)–Hewitt Lake Area, District of Kenora.
Scale 1:31 680 or 1 inch to ½ mile.

ABSTRACT

The Hewitt Lake area encompasses about 330 km^2 and is located some 170 km north-northeast of Red Lake between North Spirit and MacDowell Lakes. The map-area is underlain by Early Precambrian (Archean) rocks which may be assigned to two broad rock associations, a metavolcanic-metasedimentary association, the so called "greenstone", and a batholithic granitic intrusive rock association.

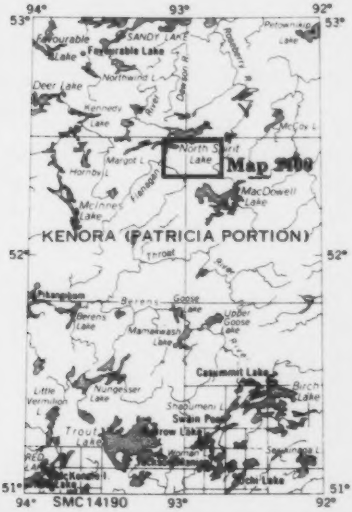

94°
93°
92°
53°
53°
Favourable Lake
Favourable Lake
SANDY LAKE
Petownikip Lake
Northwind L.
Deer Lake
Dawson R.
River
Roseberry R.
Kennedy Lake
McCoy L.
North Spirit Lake
Map
Margot L.
Hornby L.
Flanagan
MacDowell Lake
McInnes Lake
KENORA (PATRICIA PORTION)
52°
52°
Throat
River
Berens
Goose Lake
Berens Lake
Upper Goose Lake
Mamakwash Lake
Birch Lake
Little Vermilion L.
Nungesser Lake
Shabumeni L.
Swain Post
Trout Lake
Woman L.
RED LAKE
McKenzie I.
51°
51°
94°
SMC 14190
93°
92°

Figure 1–Key map showing location of the Hewitt Lake Area.
Scale 1:3 168 000 (1 inch to 50 miles).

The metavolcanics range in composition from ultramafic to felsic; a large proportion of the more felsic rocks are pyroclastic in origin. The metasediments consist of conglomerate, sandstone, mudstone, chert, and carbonate. Ultramafic, mafic, intermediate, and felsic intrusive rocks were emplaced in the volcanic and sedimentary strata. These rocks were subsequently folded. Two directions of fold axes can be identified in some localities. The metavolcanics and metasediments have a general northwest strike and are locally metamorphosed to a high grade. These rocks are intruded by batholithic granitic rocks which within the map-area outcrop east and west of the "greenstones".

The major folds are isoclinal and strike northwest; smaller scale folds strike northeast. Large scale northwest-trending faults are present, particularly in the western part of the map-area.

Showings of copper, gold, lead, molybdenum, nickel, and silver mineralization are present in the map-area.

CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

If the reader wishes to convert imperial units to SI (metric) units or SI units to imperial units the following multipliers should be used:

CONVERSION FROM SI TO IMPERIAL			**CONVERSION FROM IMPERIAL TO SI**		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
			LENGTH		
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
			AREA		
1 cm²	0.155 0	square inches	1 square inch	**6.451 6**	cm²
1 m²	10.763 9	square feet	1 square foot	**0.092 903 04**	m²
1 km²	0.386 10	square miles	1 square mile	2.589 988	km²
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
			VOLUME		
1 cm³	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm³
1 m³	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m³
1 m³	1.308 0	cubic yards	1 cubic yard	0.764 555	m³
			CAPACITY		
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
			MASS		
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
			CONCENTRATION		
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy)/ton (short)	20.0	pennyweights/ton (short)
1 pennyweight/ton (short)	0.05	ounce (troy)/ton (short)

NOTE–Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries published by The Mining Association of Canada in co-operation with the Coal Association of Canada.

Geology
# of the
Hewitt Lake Area

District of Kenora
(Patricia Portion)

by

John Wood[1]

INTRODUCTION

Area, Location, and Means of Access

The map-area encompasses 330 km² of the Patricia Portion of the District of Kenora between Latitudes 52°21′30′′N and 52°28′45′′N and Longitudes 92°42′30′′W and 93°05′00′′W.

The centre of the map-area is approximately 170 km north-northeast of Red Lake (Figure 1) where aircraft, which provide the only efficient means of access, may be chartered. Canoes can be used for transportation within the western part of the map-area where Hewitt Lake, Hewitt Creek, Little Hewitt Lake, the Flanagan River, Harling Creek, and Margot Lake are interconnected by water. Three portages, the longest about 240 m in length, are required to navigate Hewitt Creek from Hewitt Lake to Little Hewitt Lake. A portage, about 200 m long, between the Flanagan River and Margot Lake bypasses rapids. North Spirit Lake can be reached by canoe from Margot Lake via the Flanagan River. In the eastern part of the map-area, the Roseberry River is navigable, although the northwest-flowing part is boulder-strewn. Wapisipi Lake can be reached by watercraft from North Spirit Lake using a portage 335 m long to Nemakwis Lake and another portage 120 m long from Nemakwis Lake to Wapisipi Lake. These portages are outside the map-area.

---

[1] Geologist, Ontario Geological Survey, Toronto. Manuscript accepted for publication by the Chief Geologist, 15 February 1977. This report is published with the permission of E.G. Pye, Director, Ontario Geological Survey.

Fieldwork

Geological mapping of the Hewitt Lake area at a scale of 1:15 840 (1 inch to ¼ mile) was done during the summers of 1972 and 1973. Preliminary geological maps were published in 1972 and 1974 (Wood 1972c; Wood and Hunter 1974). A geological report for the North Spirit Lake area, adjacent to the north, was published in 1977 (Wood 1977).

Basemaps were prepared by the Surveys and Mapping Branch, Ontario Ministry of Natural Resources, from Forest Resources Inventory sheets. Aerial photographs at a scale of 1:15 840 taken in 1955 were obtained from the Silviculture Section, Forest Management Branch, Division of Forests, Ontario Ministry of Natural Resources, and were used in field mapping. During the second field season air photographs provided in 1973 by the Remote Sensing Unit of the Ontario Ministry of Natural Resources with the cooperation of the Northwestern Region of the Ontario Ministry of Natural Resources were used to interpret the 1955 "Silviculture" air photos. Some of the 1955 photos were of only marginal use in the field because of radical changes in the vegetation brought about by recent forest fires.

The shorelines of most lakes and most outcrops visible on the air photos were examined by the field party. Owing to lack of time caused by inclement weather during the second field season, some parts of the eastern half of the map-area were mapped using a 0.4 km grid line pattern for traverses.

Strong local magnetic anomalies in some parts of the area require that a watch and a table of sun-bearings against-time be used to make traverses. During periods of cloudy weather, fieldwork independent on a cut grid should be avoided in areas adjacent to iron formation.

Acknowledgments

The senior assistant during the 1973 field season was Mati Raudsepp; junior assistants were Barrie Hoffman, F.J. Longstaffe, and Gerhardt Pflug. The senior assistant during the 1974 field season was A.D. Hunter; junior assistants were H.I. Gibson, M.W. Hodgson, and J.M. Lafonde. The enthusiastic and capable help of these assistants is appreciated by the author. The many courtesies extended by personnel of Sabourin Lake Airways of Cochenour, Ontario, are gratefully acknowledged. Mining company reports in the Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake, were used by the author to reconstruct the history of exploration within the map-area. The cooperation of A.P. Pryslak, a former Resident Geologist in Red Lake and his predecessor, R.A. Riley, is gratefully acknowledged. The author is indebted to A.D. Hunter for his assistance in doing thin section petrography, mineral frequency analyses, and drafting diagrams for this report.

Previous Geological Work and Prospecting Activity

M.E. Hurst (1929) mentioned the prospecting of greenstones adjacent to Spirit (Fairy or North Spirit) Lake. A geological report on the North Spirit Lake area written by J.D. Bateman (1938) was the first definitive work on the geology and exploration of the area. The field work for Bateman's report was done in 1937 (Bateman 1938, p.45) and served to define:

> a sedimentary-volcanic belt, extending southeast of North Spirit Lake, through Hewitt Lake to MacDowell Lake, a distance of 22 miles [35.2 km] and averaging 5 to 8 miles [8 to 12.8 km] in width.

In 1960 and 1962, the Geological Survey of Canada did reconnaissance mapping of NTS Sheet 53C within which the Hewitt Lake area is located (Donaldson 1961; 1969). This mapping did little to change Bateman's map (1938). The sedimentary rocks of the North Spirit Lake area were studied in considerable detail by J.A. Donaldson and G.D. Jackson (1965) who described the rocks, discussed associated problems, and made suggestions for further work. The author mapped the area immediately to the north of the Hewitt Lake area in 1971 (Wood 1972a,b; 1977).

The early mineral exploration activity concentrated on finding gold mineralization (Bateman 1938). Recent exploration has been directed towards finding base metals and iron. Details of the exploration activity within the map-area are given in the section of this report entitled "Descriptions of Properties and Occurrences".

The map-area is covered by ODM-GSC Aeromagnetic Maps 867G, 877G, and 7012G (ODGM-GSC 1963, 1960a and b).

Topography and Drainage

The western three quarters of the map-area is drained by the Flanagan River System, and the eastern quarter is drained by the Roseberry River System. These two rivers flow into Sandy Lake, which drains into Hudson Bay via the Severn River. River gradients are low throughout the map-area. Small waterfalls and rapids are present on both river systems.

Relief in the map-area is very low, the highest ground, along the north-trending watershed southeast of Hewitt Lake, is over 360 m above mean sea level. The lowest part of the map-area is the South Bay of North Spirit Lake which is less than 340 m above mean sea level (see NTS Sheet 53C). Swamps are a dominant feature of the landscape. The size and number of swamps have been greatly increased by beaver.

In addition, due to the low relief, most of the rock outcrops in the map-area are two dimensional. Due to the effects of the Pleistocene glaciation most outcrop surfaces are smoothly polished.

Natural Resources

Trees in the area include: jackpine, which prefers sandy soil; spruce; poplar; balsam; and tamarac. Fires, a regular feature of the summer season, are allowed to burn uncontrolled. Consequently trees vary from stark, black, ghostlike remnants found in recently burned areas through all stages of growth to those trees found in stands of relatively mature timber.

Although the inhabitants of the North Spirit Lake village located approximately 3 km north of the outlet of the Flanagan River from Margot Lake do not practise agriculture, the Mennonite representative resident in the village during 1971 affirmed that during the years he had spent at North Spirit Lake, he had been able to grow most of the common garden vegetables. The parts of the map-area best suited to agriculture are probably those underlain by well-drained fine-grained (sand-silt) Pleistocene sediments. One such area occurs east-northeast of the eastern end of Hewitt Lake and north of the 90° bend in the Roseberry River in the southeast part of the map-area.

GENERAL GEOLOGY

The Hewitt Lake area covers the central part of the North Spirit Lake-MacDowell Lake Metavolcanic and Metasedimentary Belt herein called the North Spirit Lake Belt. Isoclinally folded metavolcanics and metasediments intruded by stocks, dikes, and sills of ultramafic, mafic, intermediate, and felsic igneous rocks occur in the central part of the map-area. These rocks are bounded to the east and west by felsic to intermediate batholithic intrusions. A diabase dike, probably of Middle or Late Precambrian age, is present in the western part of the area, and post-dates all other bedrock units which are Early Precambrian (Archean) in age. Pleistocene and Recent deposits cover a large proportion of the map-area.

The North Spirit Lake Belt consists of rocks of greenschist facies metamorphic rank, except for those rocks close to the contact with the Margot Lake granitic rocks where the metamorphism is of hornblende-cordierite facies rank.

In the region south of South Bay, cross-folding of the isoclinally folded strata has occurred. The western contact of the North Spirit Lake Belt and the granitic batholithic rocks is a southeast-trending fault zone with a downdrop to the north. This fault zone has been mapped from Favourable Lake to MacDowell Lake and is probably much longer than this (Ayres and Raudsepp 1970). Within the fault zone between Favourable Lake and North Spirit Lake, subsidiary faults branch from the main fault zone. These branch faults are generally arcuate, occur on the northeast side of the main fault zone, and appear to die out as soon as their strike direction tends towards east-northeast which usually occurs some 10 to 20 km from the point of branching. The North Spirit Lake Fault just to the north of the map-area (Wood 1977) is such a fault.

Precambrian

EARLY PRECAMBRIAN (ARCHEAN)

Metavolcanics

The metavolcanics constitute a volumetrically important part of the North Spirit Lake Belt and are ultramafic, mafic to intermediate, and intermediate to felsic in composition. The mafic to intermediate and felsic to intermediate classes have been subdivided on the basis of textural characteristics (see Table 1, and Legend on Map 2408, back pocket). No attempt has been made to subdivide the ultramafic class because this would be dependent on further detailed field and laboratory work. The threefold classification is based on chemical, microscopic, and macroscopic features; the last being of particular importance since a classification scheme should be readily applicable in the field.

The ultramafic metavolcanics are dark brown or pale green on the weathered surface; on a fresh surface these rocks are usually dark green, but may be black or light green. These rocks have a very high colour index, in excess of 90, often show spinifex texture, and are low in silica (less than 45 percent).

The weathered surface of the mafic to intermediate metavolcanics is a medium green to dark green. Visual inspection of the weathered crust of a hand specimen generally reveals the presence of feldspathic minerals, but no quartz; the silica content of these rocks is between 45 percent and 55 percent.

The intermediate to felsic metavolcanics are buff on the weathered surface, generally black on the fresh surface, often contain recognizable phenocrysts of quartz and/or feldspar, do not contain large amounts of mafic minerals, and contain more than 55 percent silica.

Preliminary maps of the area (Wood 1972c; Wood and Hunter 1974) show separate intermediate and felsic classes of metavolcanics. Subsequent work though, has shown that, based upon mineralogy and colour index, a clear-cut field subdivision into mafic, intermediate, and felsic rocks is not consistently possible.

Two of the factors which complicate a detailed subdivision are diagenesis and metamorphism. For example near Wapisipi Lake there are ultramafic rocks of low metamorphic rank, and in the western part of the map-area, similar rocks are metamorphosed to hornblende-hornfels facies. Thus, two chemically similar rocks that occur in different parts of the map-area have contrasting mineral assemblages, textures, and colours.

Within the map-area, the felsic to intermediate metavolcanics are exposed over a larger area than the mafic to intermediate metavolcanics. The ultramafic metavolcanics are areally the most restricted.

TABLE 1 TABLE OF LITHOLOGIC UNITS FOR THE HEWITT LAKE AREA.

- PHANEROZOIC
  - CENOZOIC
    - QUATERNARY
      - RECENT
        - Fluvial, lacustrine, and swamp deposits
      - PLEISTOCENE
        - Till, gravel, sand, silt, and clay

Unconformity

- PRECAMBRIAN
  - LATE PRECAMBRIAN
    - MAFIC INTRUSIVE ROCKS
      - Diabase

Intrusive Contact

- EARLY PRECAMBRIAN
  - FELSIC AND INTERMEDIATE IINTRUSIVE ROCKS
    - BATHOLITHIC GRANITIC ROCKS
      - BIOTITIC ROCKS
        - White garnetiferous pegmatite; leucocratic garnet-biotite-muscovite-quartz monzonite; pink pegmatite; aplite; porphyritic biotite quartz monzonite, trondhjemite, granodiorite; equigranular biotite quartz monzonite, trondhjemite, granodiorite
      - HORNBLENDIC ROCKS
        - Porphyritic biotite-hornblende trondhjemite, granodiorite; equigranular biotite-hornblende trondhjemite granodiorite; porphyritic hornblende-biotite trondhjemite, granodiorite, equigranular hornblende-biotite trondhjemite, granodiorite; quartz (biotite) diorite; diorite

Intrusive Contact

- METAMORPHOSED GRANITIC ROCKS
  - Porphyritic microtrondhjemite and microdiorite; porphyritic microgranite; biotite trondhjemite, granodiorite

Intrusive Contact

- METAMORPHOSED MAFIC INTRUSIVE ROCKS
  - Metagabbro, metadiorite

Intrusive Contact

- METAMORPHOSED ULTRAMAFIC INTRUSIVE ROCKS
  - Serpentinite; amphibolite; talc schist

Intrusive Contact

- METASEDIMENTS
  - CHEMICAL METASEDIMENTS
    - CARBONATE METASEDIMENTS
      - Marble, impure marble
    - SILICEOUS AND FERRUGINOUS METASEDIMENTS
      - Chert; chert with pyrite, pyrrhotite; chert-pyrrhotite iron formation; chert with magnetite, pyrite, pyrrhotite; ferruginous chert (magnetite-bearing); chert-magnetite iron formation

    - PARA-AMPHIBOLITES
      - Para-amphibolite; thinly bedded para-amphibolite
  - CLASTIC METASEDIMENTS
    - MUDSTONES
      - Shale, mudstone; black shale; siltstone, medium to thinly bedded; siltstone, thinly to very thinly bedded; graded siltstone-shale; biotite-andalusite-muscovite schist; sillimanite-garnet-staurolite-muscovite schist; cordierite-sillimanite-biotite schist; cordierite-biotite schist
    - SANDSTONES
      - Quartz arenite, arkose, subarkose, lithic arkose; lithic arkosic wacke, lithic subarkosic wacke, granular and thickly bedded; lithic arkosic wacke, lithic subarkosic wacke, medium bedded; lithic arkosic wacke, lithic subarkosic wacke, thinly bedded; graded wacke-mudstone; feldspathic lithwacke; cordierite-biotite schist; garnet-andalusite-muscovite-biotite schist
    - CONGLOMERATES (POLYMICTIC)
      - Boulder to granule orthoconglomerate, arenaceous matrix; cobble to granule orthoconglomerate, arenaceous matrix; boulder to granule paraconglomerate, arenaceous matrix; boulder to pebble paraconglomerate, argillaceous matrix; boulder to granule orthoconglomerate, feldspathic lithwacke matrix; boulder to pebble orthoconglomerate, argillaceous matrix
- METAVOLCANICS
  - FELSIC TO INTERMEDIATE METAVOLCANICS
    - Flows; porphyritic flows; tuff; lapilli-tuff; tuff-breccia
  - MAFIC TO INTERMEDIATE METAVOLCANICS
    - Flows, pillowed, amygdaloidal, coarse grained, carbonatized, and porphyritic; tuff, lapilli-tuff; tuff-breccia; garnetiferous metavolcanics
  - ULTRAMAFIC METAVOLCANICS
    - Flows, bedded clastic rock

ULTRAMAFIC METAVOLCANICS

For many years it was accepted that ultramafic rocks were restricted to the plutonic environment. For example, F.H. Hatch *et al.* (1972, p.424) in their discussion of ultramafics and anorthosites stated:

> They are confined to the plutonic environments and have no extrusive equivalents.

D.W. Hyndman (1972) made no mention of ultramafic lavas, and of alpine peridotite-serpentinite bodies stated on p.112.

> Almost certainly the peridotite was not 100 percent liquid when emplaced, as the temperature required would be prohibitive.

Recently, Early Precambrian (Archean) ultramafic rocks believed to be of extrusive origin have been found in Africa, Australia, and Canada (see Pyke *et al.* 1973).

In the map-area, ultramafic metavolcanics have been identified in the region between Wapisipi Lake and Makataiamik Lake. Ultramafic rocks occur in other parts of the map-area such as near Little Hewitt and Hewitt Lakes, where, as far as can be determined, the ultramafics form concordant sheets or lenses. Nearly all outcrops of ultramafic rocks in the western part of the map-area are small, and the rocks are deformed and metamorphosed. Evidence for an intrusive or extrusive origin, details of which are given below, either may be unexposed, or may have been obliterated. Those ultramafic bodies showing no evidence for an extrusive origin are coded as intrusive on the accompanying map.

The petrography of the ultramafic rocks in the map-area is described in the following sections.

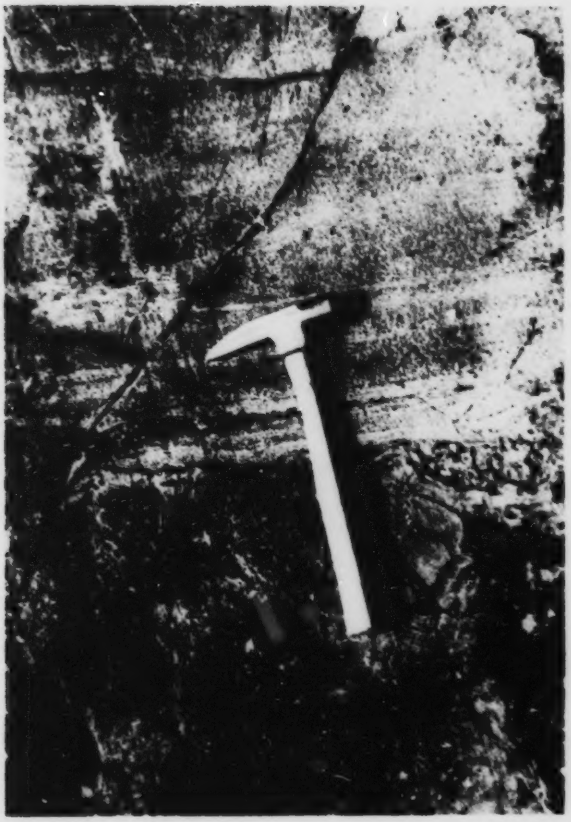
Ultramafic Rocks Between Wapisipi and Makataiamik Lakes

Several excellent exposures of ultramafic rocks including ultramafic metavolcanics occur between Wapisipi Lake and the crescent-shaped lake south of Wapisipi Lake. Exposure is poor southeast of this crescent-shaped lake. Southwest of Wapisipi Lake, the apparent thickness of the ultramafic rock sequence is about 600 m.

Metavolcanics constitute about three quarters of the sequence. The observed 460 m thickness of metavolcanics represents a minimum thickness of the original volcanic pile because no reversals of stratigraphic top directions were noted at this locality; and the flow rocks dip vertically and are overlain apparently unconformably by other rock types.

The proportions of metavolcanic to meta-intrusive rock northwest of Wapisipi Lake [out of the map-area] are not known because of the structural complexity in that locality. Between Makataiamik Lake and the crescent-shaped lake, the proportions of extrusive to intrusive rocks are not known because of the small amount of outcrop. The outcrops north of the western end of Makataiamik Lake near where the ultramafic rocks are truncated by the batholithic granitic rocks are interpreted by the author to be of extrusive origin.

The ultramafic rocks weather to a medium to dark brown or pale green. On fresh surfaces they are dark green, almost black, but have a greenish hue. The ultramafic rocks interpreted by the author to have an intrusive origin, are massive on outcrop surfaces. In contrast, the flow rocks show chilled bases and chilled and fractured flow tops. The bottom part of Photo 1, illustrates a chilled and fractured flow top. The chilling at the base of the flow in the top part of the photograph is not readily perceived in this illustration. Some flow units exhibit pillow structures. Spinifex texture, a common characteristic of reported ultramafic metavolcanics (Pyke *et al.* 1973), is present in some flow units. The thinner flows, those less than 0.6 m thick, generally exhibit spinifex texture on a scale measured in millimetres. The larger blades in some of the thicker flows exceed 0.3 m in length. Pyke *et al.* (1973) subdivided some of the flows in Munro Township into six zones (Figure 2). In the map-area, any flow having spinifex texture always displays the "A1" and "A2" zones, and most of the "B" zones of Pyke *et al.* (1973).



OGS 10 154

Photo 1–Ultramafic metavolcanics. The chilled and fractured top of a flow can be seen in the lower half of the photograph. Near the top of the photograph is the chilled base of another flow. The original nature of the intervening material is not known, it may represent tuffaceous or sedimentary ultramafic detritus. The hammer handle is 33 cm long.

Small dikes about 0.3 m wide, transect the flow units and mainly show spinifex texture throughout, but the dike margins are usually fine grained.

Photo 1 shows some of the bedded clastic, tuffaceous, rocks in the metavolcanic sequence. On outcrop, the clastic rocks are well bedded. Some outcrops display low angle crossbeds, others exhibit graded bedding. Most of these rocks occur between flows in units less than 0.6 m thick. A pod-like area, 120 m by 460 m, underlain by amphibolitic rocks, occurs to the northwest, but is just beyond the map-area, and is considered by H.L. Gibson (field assistant during the 1973 and 1975 seasons) to have a tuffaceous origin (Gibson 1976).

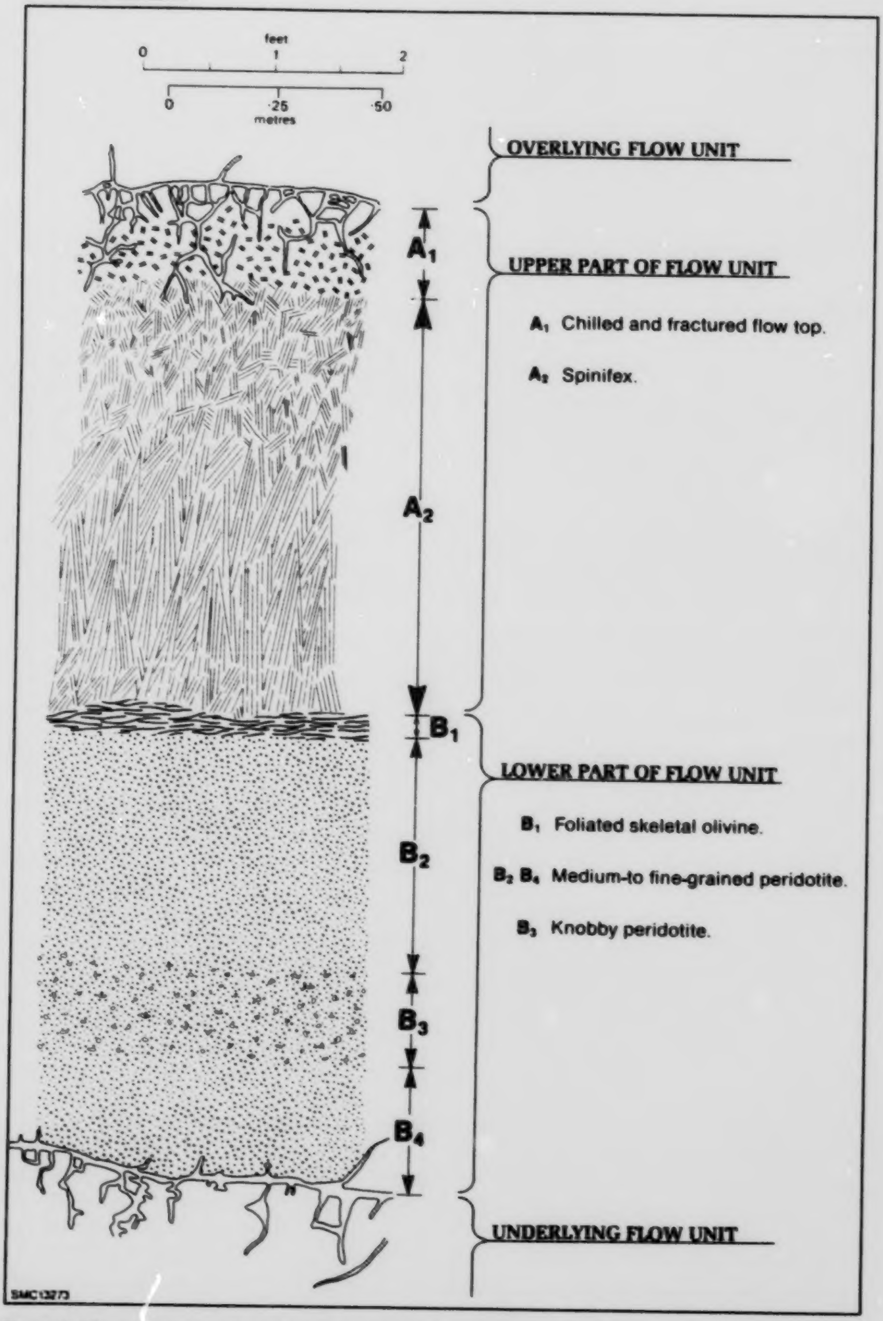

feet
0
1
2
0
·25
·50
metres
OVERLYING FLOW UNIT
A_1
UPPER PART OF FLOW UNIT
A_1 Chilled and fractured flow top.
A_2 Spinifex.
A_2
B_1
LOWER PART OF FLOW UNIT
B_1 Foliated skeletal olivine.
B_2 B_4 Medium-to fine-grained peridotite.
B_3 Knobby peridotite.
B_2
B_3
B_4
UNDERLYING FLOW UNIT
SMC13273

Figure 2–Diagrammatic section of an ultramafic flow (after Pyke *et al.* 1973).

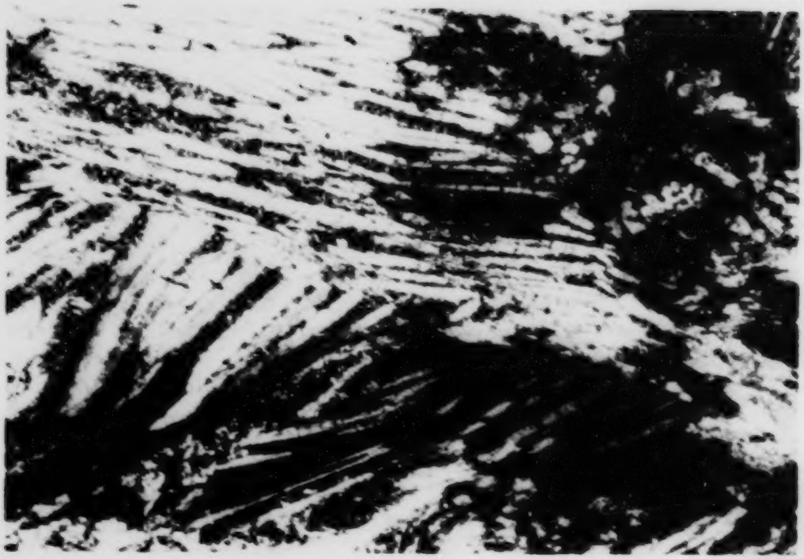

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Photo 2–Photomicrograph of spinifex texture in an ultramafic flow. The spinifex fronds are composed of single crystals of tremolite. The small roundish structures in the top right of the photograph are transverse cross-sections of fronds. Field of view is 2.5 mm.

In thin section, the interflow tuffaceous rocks consist primarily of angular fragments with subordinate smoothly rounded fragments set in a fine-grained matrix. Some chlorite and carbonate can be recognized in thin section, but the mineralogy of the bulk of the rock is indeterminate by optical means.

The maximum crystal size observed in outcrop of the "B" Zone of a flow within the map-area was about 4 to 5 mm; most crystals are smaller than this. Examination of thin sections from the "B" Zone of thin flows reveals that many crystals are about 0.5 mm in size. Most of the original minerals have been altered; however, in one thin section (G-73-1) crystals of olivine were observed in varying degrees of preservation. Antigorite, tremolite, carbonate, and oxide minerals constitute the other minerals in this thin section. A significant feature, perhaps, is that the olivine crystals, although stumpy in habit, show an orientation of their "C" axes in one plane; this may indicate orientation of crystals by flowage during extrusion. The mineralogy varies from place to place. Carbonate, tremolite, antigorite (serpentine), and iron oxides are present in all four thin sections examined from the "B" zones of flow units. Penninite and talc are present in two of the thin sections.

The spinifex zones of the flows differ markedly in texture from the "B" zone. The spinifex fronds are set in a very fine grained matrix (Photo 2). Glass was not observed in thin section. In one thin section tremolite, chlorite, and carbonate, were observed, but in others, the mineralogy of the matrix could not be determined. The finer grained spinifex fronds are about 0.06 mm wide and 1 to 5 mm long, the coarser fronds seen in thin section were 1 to 2 mm wide and a centimetre or more in length.

Tremolite-actinolite and iron oxides are the dominant minerals comprising the spinifex fronds, although chlorite, serpentine, and carbonate are frequently present. Examination of thin sections, reveals that in the fine-grained spinifex, a single tremolite crystal usually forms a single spinifex frond, whereas in the coarser grained varieties, a single spinifex frond consists of many amphibole crystals.

Table 2 provides chemical data for selected samples from the metavolcanic sequence southwest of Wapisipi Lake. The chemistry of the rocks is broadly similar to that reported for ultramafic metavolcanics from Munro Township, Ontario (Pyke *et al.* 1973) and the Barberton area, South Africa (Viljoen and Viljoen 1969). The rocks from near Wapisipi Lake are rich in MgO and CaO and low in alkalis and TiO_2. Figure 3 diagrammatically illustrates the ratios of CaO to Al_2O_3. All of the samples have CaO/Al_2O_3 ratios exceeding 1. This compares to samples from South Africa (Viljoen and Viljoen 1969), but differs from samples from Munro Township which generally have CaO/Al_2O_3 ratios less than 1. For example, the analyses of Pyke *et al.* (1973) have CaO/Al_2O_3 ratios less than 1, as do most of the analyses, also from Munro Township, of N.T. Arndt (1975).

Figure 4 shows the position of the analyzed samples on a MgO-CaO Al_2O_3 diagram. The fractionation trend indicated is broadly similar to that for the Munro Township rocks (Arndt 1975). However, the primary difference is the slightly more Ca rich nature of the Wapisipi Lake rocks. The trend is not comparable to the trend of the very high CaO/Al_2O_3 rocks of the Barberton area (Nesbitt 1971).

Ultramafic Rocks South and West of Hewitt Lake

All the ultramafic rocks located west of a line passing through the South Bay of North Spirit Lake, the "V" in Hewitt Lake, and the eastern end of Nipa Lake are schistose, and are either amphibolitic, talcose, or both. East of this line and south of Hewitt Lake, the ultramafic rocks locally are amphibolitic and talcose, are generally equigranular, have a low metamorphic grade, and do not have a strong directional fabric. The textural difference is probably related to the degree of deformation; south of Hewitt Lake deformation has been much less intense than west and southwest of Hewitt Lake. The intensity of deformation in the western part of the North Spirit Lake Belt is directly related to the regional fault system (see Figure 10 and the introductory section of "General Geology") part of which traverses the rocks in the western part of the belt.

In the western half of the map-area, outcrops of the ultramafic rocks are usually small and sparsely distributed; little can be gleaned of the original nature of the rocks. The ultramafic rocks are dark green to black on fresh and weathered surfaces. Talc schist is readily recognizable by being soft and easily scratched.

TABLE 2 CHEMICAL ANALYSES OF ULTRAMAFIC METAVOLCANICS, HEWITT LAKE AREA, CHEMICAL ANALYSES BY GEOSCIENCE LABORATORIES, ONTARIO GEOLOGICAL SURVEY.

	SPINIFEX						CUMULATE
Sample Number	GT-73-3	GT-73-6	H-T75-200	HT-75-201	H-T75-202	H-T75-203	GT-73-2
	Major Components in Weight Percent						
SiO_2	44.60	45.40	42.80	43.80	45.60	45.20	41.30
Al_2O_3	6.07	5.14	7.12	7.34	8.10	8.20	3.64
Fe_2O_3	5.53	5.79	4.04	2.50	1.80	1.40	4.05
FeO	6.90	6.40	8.15	9.54	9.54	9.54	5.03
MgO	23.10	23.80	22.60	21.00	19.90	20.20	30.70
CaO	7.15	7.96	7.46	8.24	8.84	8.81	4.61
Na_2O	0.32	0.19	0.19	0.46	0.75	0.73	0.16
K_2O	0.02	0.02	0.00	0.00	0.00	<0.05	0.02
H_2O^+	4.31	3.72	4.72	4.10	3.84	3.43	6.84
H_2O^-	0.54	0.38	0.68	0.66	0.66	0.54	0.44
CO_2	0.10	0.20	0.07	0.12	0.10	0.08	1.80
TiO_2	0.37	0.37	0.30	0.30	0.33	0.30	0.20
P_2O_5	0.03	0.03	<0.01	<0.01	<0.01	<0.01	<0.02
S	0.01	0.02	0.01	<0.01	<0.01	<0.01	0.03
MnO	0.18	0.21	0.16	0.19	0.21	0.21	0.18
Total	99.23	99.63	98.31	98.27	99.69	98.71	99.02

	CUMULATE				PILLOWED		MASSIVE	CLASTIC
	GT-73-4A	H-T75-6	H-T75-204	H-T75-205	H-T75-206	H-T75-209	H-T75-39	GT-73-4B
SiO_2	35.50	40.10	47.10	40.70	42.60	44.60	41.70	48.20
Al_2O_3	3.45	2.75	7.20	4.43	5.25	5.90	4.40	4.02
Fe_2O_3	7.08	7.78	1.79	3.04	3.40	3.41	5.80	3.97
FeO	6.50	5.96	8.65	6.12	6.12	5.75	6.12	5.35
MgO	30.00	29.50	20.90	28.00	27.40	25.80	28.50	24.40
CaO	3.51	3.65	8.94	5.74	5.75	7.01	4.93	6.03
Na_2O	0.05	0.00	0.49	<0.05	0.05	0.05	0.00	0.11
K_2O	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.02
H_2O^+	7.49	7.56	3.31	6.79	6.08	5.73	6.26	3.63
H_2O^-	0.43	0.54	0.67	0.22	0.41	0.36	0.59	0.49
CO_2	4.80	0.19	0.12	3.56	0.51	0.46	0.86	3.20
TiO_2	0.11	0.27	0.27	0.20	0.24	0.22	0.23	0.21
P_2O_5	<0.02	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03
S	0.03	<0.01	<0.01	0.02	0.05	0.12	0.04	0.01
MnO	0.30	0.27	0.19	0.15	0.17	0.17	0.19	0.27
Total	99.29	98.59	99.65	99.03	98.04	99.59	99.63	99.94

Abbreviation:
< - less than

Four out of five thin-sectioned samples of ultramafic rock taken from outcrops west and southwest of Hewitt Lake, and west of Little Hewitt Lakes are characterized by strongly foliated amphiboles, tremolite, or actinolite and generally comprise more than 50 percent of the rock. The fifth sample taken from the bed of Hewitt Creek about 0.4 km west of Little Hewitt Lake consists largely of fine-grained talc-rich layers; elongate and equant serpentine pseudomorphs occur in other parts of the sample. Tremolite has apparently developed from talc in the last-mentioned sample. This indicates that a thermal metamorphic event took place after the shearing which produced the talc. Other minerals seen in this thin section are iron oxides and carbonate. The outcrop from which the sample was taken has a brecciated appearance.

Two of the other four samples are from outcrops along Hewitt Creek between Hewitt and Little Hewitt Lakes; the third was taken just to the south of Hewitt Lake, about midway along the western arm. The fourth was taken from the north shore of Nipa Lake. Because of their strongly foliated amphibolitic appearance on outcrop surfaces, all these rocks could easily be misidentified as mafic metavolcanics. The general lack of feldspar in the weathered rind indicates the ultramafic character of these rocks. The amphibole content gives the rocks an appearance similar to that of the adjacent mafic metavolcanics. This contrasts with the green serpentinized massive appearance of the ultramafic rocks east of Hewitt Lake.

The two samples taken from near Hewitt Creek contain iron oxides; one contains about 15 percent, the other about 3 percent iron oxides. The sample containing 15 percent iron oxides also contains serpentine (about 35 percent), carbonate (about 2 percent), and as mentioned above tremolite (about 45 percent); the other sample contains a trace of sphene, about 10 percent quartz and feldspar, and about 87 percent actinolite. The quartz and feldspar in the latter occur in lensoid areas.

Thin section examination reveals that the other two rocks consist of about 90 percent actinolite, 5 percent quartz and feldspar, 2 percent iron oxides and sphene; accessory minerals of one rock are biotite which locally replaces actinolite and carbonate, and of the other rock they are chlorite, biotite, and epidote. The quartz and feldspar occur as fine-grained interstitial polygonal aggregates and may be of secondary origin.

South of the eastern part of Hewitt Lake there are some large outcrops, but the outcrop density is low. Large outcrops reveal that the ultramafic rocks are massive and may be either brown or dark green. On fresh surfaces they are dark green almost black with no suggestion of feldspathic minerals on the weathered rind. Some sheared outcrops on the south shore of the eastern arm of Hewitt Lake are light pale green, amphibolitic, talcose, and schistose.

Thin section examination of a sample from one of the more massive rock outcrops east of the "V" in Hewitt Lake, shows the rock to be fine grained. The rock is equigranular, some grains are equant, some elongate, and the minerals present are serpentine (about 80 percent), iron oxides (about 12 percent), talc (about 5 percent), and carbonate (about 3 percent). The maximum grain diameter is about 1.5 mm with an average around 0.9 mm. The grain sizes were measured on crystal pseudomorphs. The original rock from which this sample was taken probably closely approximated a dunite. A thin section of a sample from an outcrop on the southern shore of the eastern arm of Hewitt Lake consists of

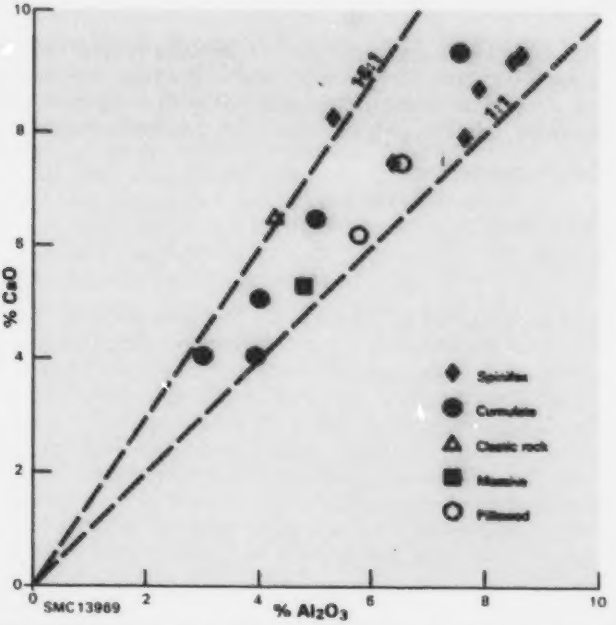

Figure 3–Percentage CaO versus Al_2O_3 diagram for ultramafic metavolcanics from the Hewitt Lake area.

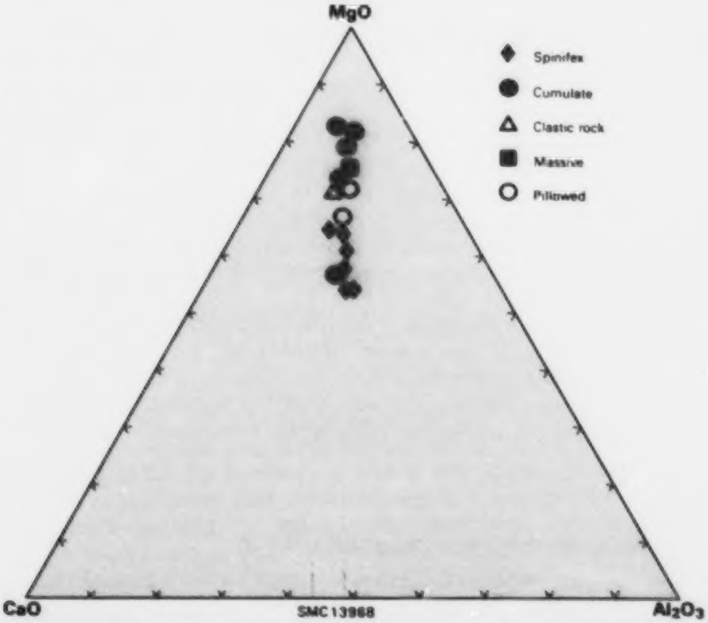

Figure 4–MgO-CaO-Al_2O_3 plot of ultramafic metavolcanics from the Hewitt Lake Area.

tremolite (about 40 percent), chlorite and serpentine (about 58 percent), and iron oxides (about 2 percent). Grains of tremolite are bent and broken suggesting some deformation after tremolite crystallization. In outcrops, an amphibole lineation is apparent, and the rock can easily be mistaken for a mafic metavolcanic.

Conclusions

The ultramafic rocks can be divided into four groups based on mineralogy and texture. The first group, those rocks between Wapisipi Lake and the western end of Makataiamik Lake, contains remnants of original olivine and are essentially composed of serpentine, tremolite, iron oxides, carbonate, and olivine. This group includes the following: intrusive rocks; extrusive rocks characterized by chilled and fractured margins, pillow structures, and spinifex textures; and clastic rocks characterized by well-developed bedding. The second group consists of the ultramafic rocks south of the eastern part of Hewitt Lake. The rocks are massive, equigranular, contain no original minerals, have pseudomorphs probably after olivine, and contain serpentine, iron oxides, talc, carbonate, and tremolite. The third group comprises the ultramafic rocks that occur in the western part of the area, particularly in the vicinity of Hewitt Creek. The rocks are foliated, and consist of tremolite, serpentine, iron oxide, and carbonate. Rocks of the fourth group are also foliated, and occur in the western part of the map-area; they consist of actinolite, quartz, feldspar, and minor iron oxide, sphene, and epidote.

The ultramafic rocks southeast of Hewitt Lake have not been severely deformed. The rocks are massive and show none of the textures considered to indicate an extrusive origin. The author considers these rocks to have originated as concordant to subconcordant intrusions.

Deformation and metamorphism have affected the ultramafic rocks in the western part of the map-area, and may have been sufficiently intense to have destroyed the primary rock textures. However, it is possible that the lack of such textures is an original feature. On this basis, the rocks in the western part of the map-area may be genetically similar to those southeast of Hewitt Lake. The metagabbroic rocks in the vicinity of Little Hewitt Lake may be differentiates of a more mafic magma.

The ultramafic rocks in the vicinity of Wapisipi Lake comprise a complex which is partly intrusive and partly extrusive. Detailed mapping between the southern end of Wapisipi Lake and North Spirit Lake could indicate the proportions of the different rock types. The present investigation suggests that the ultramafic rocks in the map-area are either high-level intrusions or extrusive rocks.

MAFIC TO INTERMEDIATE METAVOLCANICS

The mafic to intermediate metavolcanics within the map-area are generally found near the edges of the metavolcanic-metasedimentary belt. These rocks are in contact with the granitic rocks along the greater part of the western margin of the belt, and at the eastern edge of the belt they occur close to or at the contact with the granitic rocks. Examples of this are near Makataiamik Lake, and further to the south near the Roseberry River. Exceptions to this are the carbonatized mafic unit which occurs near Hewitt Lake and Little Hewitt Lake (Map 2408, back pocket) and other minor occurrences of mafic to intermediate metavolcanics distributed throughout the map-area.

The mafic metavolcanics, are all dark to very dark green on the weathered surface, and can be distinguished from the high and low metamorphic grade ultramafic metavolcanics by the presence of felsic minerals on the weathered crust. The intermediate to felsic metavolcanics are generally a much lighter buff colour, are tougher, and frequently contain quartz and/or feldspar phenocrysts as compared to the mafic metavolcanics.

On Map 2408 (back pocket) and in this report, the mafic to intermediate metavolcanics have been subdivided on the basis of textural,structural, and mineralogical characteristics. Medium- to fine-grained flows, pillowed flows, and carbonatized flows are the most important volumetrically. Other mafic to intermediate metavolcanics only occur locally.

Coarse-grained flows occur near the southern boundary of the map-area about 3.2 km east of the eastern end of Nipa Lake. These rocks are considered to be flows because of their conformability with the enveloping rocks and their association with fine- to medium-grained flows. The coarse-grained flows are composed primarily of amphibole and feldspar.

Amygdaloidal mafic flows occur northwest of the western end of Makataiamik Lake, on the south shore of Hewitt Lake southeast of the island in the eastern arm of the lake, and just to the south of the "V" in Hewitt Lake. The amygdules in the Makataiamik Lake locality occur in fine- to medium-grained pillowed metavolcanics. In the other localities, pillows were not observed. The amygdules comprise quartz, feldspar, or scapolite, and may contain inclusions of amphibole or chlorite. These rocks are not different in texture and mineralogy from adjacent non-amygdaloidal fine- to medium-grained metavolcanics.

Garnetiferous mafic metavolcanics outcrop on the south shore near the eastern end of Margot Lake. The garnet crystals are about 0.5 cm in diameter, red, and occur in a strongly foliated amphibole-plagioclase rock considered by the author to have originally been volcanic because it is conformable with the adjacent metasediments.

Tuffaceous mafic metavolcanics are uncommon in the map-area. Only a few occurrences of this rock type were found, for example south of the western arm of Hewitt Lake and about 4 km east of the prominent peninsula in the eastern part of Hewitt Lake. The matrix of the rock in the last-mentioned locality appears to be similar to a mafic metavolcanic rock, but contains large clasts of felsic igneous rock which are either feldspar porphyry or felsic metavolcanics. Alternatively, the rock could be a paraconglomerate.

Except for the presence of pillow structures, the pillowed flows are similar to the nonpillowed fine- to medium-grained varieties. The carbonatized flows, although essentially similar to the unpillowed fine- to medium-grained flows, have been impregnated by carbonate veins. These rocks form a major stratigraphic unit within the map-area and will be described separately.

The mafic to intermediate metavolcanics have been affected by the same deformation and metamorphism as the ultramafic rocks. East of Hewitt Lake, the metamorphic grade is low; original textures occur in the mafic metavolcanics just south of the eastern arm of Hewitt Lake. The rocks between Nipa Lake and Little Hewitt Lake are of high metamorphic grade and are strongly foliated. Bateman (1938) on the map accompanying his report described the rocks as "bedded amphibolite". Several faults occur in this region (Map 2408, back pocket), and adjacent to these faults, the mafic metavolcanics have been mylonitized. The mylonite zones are characterized by a thin-striped appearance, alternate stripes are buff and medium to dark green. No thin sections were made of these rocks.

Only one exposure of pillowed mafic metavolcanics was found in the region between Nipa Lake and Little Hewitt Lake, and is located 1200 m south of the central part of Little Hewitt Lake. Possibly, there were never any other pillowed units in the mafic metavolcanics between Nipa and Little Hewitt Lakes, but equally, any original pillow structures may no longer be recognizable because of the effects of metamorphism and deformation. Except for the carbonatized mafic metavolcanic unit and the coarse-grained mafic metavolcanic units, all other occurrences of mafic metavolcanic flows display pillow structures. These structures vary in size, but are usually 0.5 to 1 m in length.

An example of a mafic metavolcanic of low metamorphic grade in the lower greenschist facies occurs on the southern shore of Hewitt Lake just to the east of the "V" in the lake. The rock is dark green on the weathered surface, but not as dark as the metavolcanics from the western edge of the metavolcanic-metasedimentary belt, and displays a metamorphic foliation defined by amphibole crystals. No glass was seen in thin sections of the rock. Feldspar microphenocrysts and matrix feldspar crystals are labradorite (An_{50} to An_{55}) by optical determination. Plagioclase constitutes about 57 percent of the rock. Actinolite, light green, circular, and frequently forming "sheaf-like aggregates" constitutes about 35 percent of the rock; other minerals include clinozoisite (about 5 percent), magnetite and sphene.

A thin section of a sample of amygdaloidal fine- to medium-grained mafic metavolcanic rock taken from near the granitic contact northwest of Makataiamik Lake is foliated, equigranular, and composed of labradorite (37 percent), hornblende (60 percent), and the accessory minerals, scapolite, magnetite, and sphene. Scapolite probably formed by the reaction of original calcareous minerals with other rock components. No relict mineralogical textures are preserved in the rock, but pillow and amygdule structures are present.

The mafic metavolcanics from the western edge of the North Spirit Lake Belt are strongly foliated and are usually either equigranular or porphyroblastic. The grain size, except in mylonitized zones, is coarser than in the other mafic metavolcanics which occur in the map-area except for the minor occurrences of coarse-grained flows. This coarse grain size is a result of the growth of metamorphic minerals, and is not an original igneous texture. The porphyroblastic rocks are found northwest of Nipa Lake adjacent to the contact with the batholithic granitic rocks; porphyroblasts of feldspar up to 5 mm long were observed. Incipient gneissosity is occasionally visible in outcrop, and in thin section it is revealed to be a segregation of amphibole and biotite crystals forming ill-defined irregular layers. Minerals in the porphyroblastic mafic to intermedi-

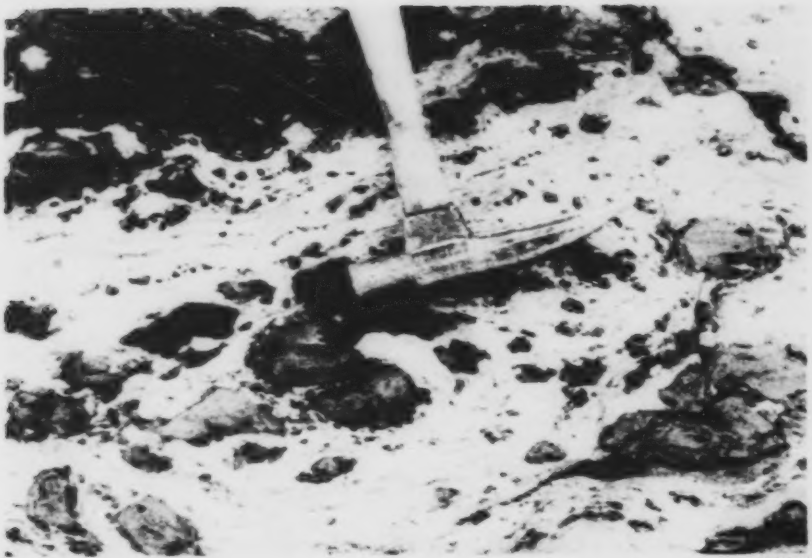

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Photo 3–Carbonatized mafic metavolcanics. The amount of carbonate is greater in the outcrop photographed than in most outcrops. The rock illustrated is little deformed; in more deformed outcrops, the carbonate and mafic metavolcanics are streaked out in layers. The hammer head is 15 cm long.

ate metavolcanics include labradorite-andesine (40 percent), hornblende (30 percent), brown biotite (15 percent), microcline (10 percent), and accessory iron oxide. Microcline and biotite are probably formed by potassium metasomatism from the adjoining granitic intrusions and do not occur in all of the mafic metavolcanics along the western edge of the North Spirit Lake Belt within the map-area.

Carbonatized mafic metavolcanics form a distinctive rock unit in the map-area. This unit is exposed intermittently from Little Hewitt Lake southeastwards to Hewitt Lake where it outcrops on the western shore of the extreme western end of the lake. It outcrops again to the south of the eastern arm of the Hewitt Lake just east of the "V" in the lake and along the southern shore of the eastern arm of the lake to a point southeast of the prominent peninsula on the northern shore. The unit outcrops on the northern shore east of the same peninsula for about 460 m. It is cut off by the Wokokotai Lake intermediate intrusive body, and apart from two small outcrops about 1200 m north-northwest of the northeastern end of Hewitt Lake no futher trace of the unit was found.

East of the prominent peninsula in the eastern part of Hewitt Lake, the unit is 300 to 360 m thick. Its thickness cannot be estimated elsewhere because of faulting in the western part of the map-area, and the low outcrop density in the other parts. The amount of carbonate present and the degree of brecciation of the metavolcanics varies from place to place, but does not appear to have any systematic pattern. Photo 3 shows a rock exposed on an island in Little Hewitt

Lake, and exhibits angular metavolcanic fragments in a carbonate matrix. On the other side of the island, bedding or apparent bedding is present in the carbonate, the bedding is defined by thin layers of mafic minerals such as chlorite or amphibole. In other localities, such as along the northern shore of the eastern arm of Hewitt Lake, just to the east of the prominent peninsula, the carbonate occurs in thin veins. These veins are generally less than 1 cm thick, but sometimes are as much as 0.3 m thick. The veins are parallel to the foliation in the metavolcanics, and frequently give rise to a striped effect. The outcrops along the northern shore in this part of Hewitt Lake provide excellent exposures of the unit. Shearing appears to have been locally intense so that mylonitic bands are present in the carbonatized rocks; amphibolite bands have the appearance of an ultramafic rock. Unfortunately shearing along this part of the shoreline has masked the relationships between rock types.

A thin section of this unit taken from an outcrop on the southern shore of the eastern arm of Hewitt Lake shows that the rock is composed largely of the following: actinolite (65 percent) which occurs in small crystals about 0.3 mm long having a parallel to sub-parallel orientation, and forming sheaf-like aggregates that are 1.5 to 2 mm in length; quartz and feldspar (25 percent) are very fine grained, about 0.02 mm in diameter, and difficult to distinguish from each other. The composition of the feldspar is not readily apparent. Carbonate forms about 5 percent of the rock and occurs in patches and stringers; sphene, magnetite, biotite, clinozoisite, and pyrite, compose the remainder of the rock. The carbonate in its present form shows no sign of having had any reaction with other minerals in the rock.

Stratigraphically close to it there are carbonate horizons, such as in the general vicinity of the eastern part of Hewitt Lake. Chert and carbonate occur stratigraphically close to the carbonatized mafic metavolcanics. Top determinations could not be made in this vicinity. Extrapolation of the structure from the northwestern part of Hewitt Lake indicates that the chert and carbonate occur below the carbonatized mafic metavolcanics. Near the western arm of Hewitt Lake, carbonate horizons appear to occur both above and below the carbonatized mafic metavolcanics. In both localities, ultramafic rocks are stratigraphically close to the carbonate-rich mafic metavolcanics. The carbonate may have been derived from fumarolic activity related to the mafic volcanism or perhaps the ultramafic volcanism. Carbonate could also be the result of remobilization of pre-existing sedimentary carbonate by the extrusive flows. Since carbonate rocks tend to be mobile during deformation, the breccias seen on outcrops in Little Hewitt Lake may be the result of carbonate movement during deformation.

Another hypothesis involves shearing related to the fault system in the western part of the map-area. Shearing of the mafic metavolcanic unit may have allowed fluids charged with carbonate from adjacent metasediments to permeate the unit. The author does not consider this in itself to be a satisfactory mechanism for carbonatization because other, extensively sheared, mafic metavolcanic units within the map-area show little evidence of carbonatization. No definitive answer can be given by the author about the origin of this rock unit; it is a problem worthy of further detailed study.

FELSIC TO INTERMEDIATE METAVOLCANICS

The felsic to intermediate metavolcanics form a volumetrically important part of the metavolcanic-metasedimentary sequence. Considerable thicknesses of these metavolcanics are present southwest and southeast of Hewitt Lake, around the South Bay of North Spirit Lake, and in a northwest-striking belt between South Bay and the northwest-flowing part of the Roseberry River. East of the eastern arm of Hewitt Lake, the thickness of the felsic to intermediate metavolcanic pile, assuming no tectonic thickening, is between 1500 and 1800 m. Thickness of the sequence west and southwest of Hewitt Lake cannot be estimated with certainty because of low outcrop density and widespread faulting.

Lava flow rocks are subordinate in volume to the pyroclastic rocks.

Ignimbrites, rocks produced by pyroclastic flow rather than by aerial transportation of detritus, were recognized in only one locality which is about 1800 m east of the most easterly part of Hewitt Lake. There are probably other occurrences of ignimbrites which were not recognized as such due to the removal by metamorphism and deformation of criteria diagnostic of pyroclastic flow.

The pyroclastic rocks have been classified according to the terminology of R.V. Fisher (1965).

Outlines of fragments, particularly those of the smaller sized fragments, are sometimes difficult to perceive in the map-area. Thus ash content was difficult to determine in some outcrops. The author considers that tuff-breccia is the coarsest size class of pyroclastic rock in the map-area because of the difficulty in determining ash content. Pyroclastic breccias may be present, but are unrecognizable in the map-area.

Within the map-area, rocks of high metamorphic grade are located close to granitic contacts. Since the felsic to intermediate metavolcanics are generally about 1.5 km from the granitic contacts, their overall metamorphic grade is low. All of the felsic to intermediate metavolcanics have been recrystallized. This recrystallization, however, has not significantly altered the grain size of the rocks in different parts of the map-area so that the flow rocks are finely crystalline as are most of the tuffs and also the larger fragments in the tuffaceous rocks. The flow rocks are often microporphyritic, microphenocrysts are up to 2 mm in diameter. Most of the pryoclastic rocks contain varying amounts of coarse-grained crystals (2 mm in size). In some localities, for instance east of South Bay, rocks considered by the author to be tuffaceous rocks are coarsely crystalline, and during field mapping posed problems as to whether they should be classified as intrusive or extrusive. Thin sections often provide textural evidence as to whether or not a rock is clastic in origin but are not available in all instances. In localities where the rocks have been cataclastically deformed and microtextures destroyed, or where a complex of intrusive and extrusive intermediate to felsic rocks exists, field relationships were used as a guide to rock genesis. As a consequence, intrusive and extrusive rocks may be classified in one category. Around Wokokotai Lake, the rocks were classified by the author as intrusive, because intrusive relationships are indicated by the outcrop pattern on the map (Map 2408, back pocket). Some rock samples from this complex, however, contain pyroclastic material; since the two rock types cannot be easily separated in the field they have been classified together.

The colour of the felsic to intermediate metavolcanics on the weathered surface is generally buff, but can be medium green, light brown, or white. The fresh surface is black; dark green surfaces were occasionally observed. Microphenocrysts of quartz are usually conspicuous in a hand sample because of their clear, crystalline appearance. The coarsely crystalline tuffs already mentioned are distinct from the other intermediate to felsic metavolcanics, and consist largely of feldspar crystals with or without rock fragments. The length of the feldspar crystals may reach 1 cm.

The lapilli- and bomb-sized fragments in the intermediate to felsic metavolcanics are usually of the same composition as the groundmass. The larger fragments may be distinctly more mafic or felsic than the groundmass. Because of the compositional similarity of the fine and coarse fragments in many of the rocks, a weathered surface may be required to distinguish coarse clasts from matrix; the two often being indistinguishable on fresh surface.

West and southwest of Hewitt Lake and near Little Hewitt Lake, cataclasis has foliated and given an incipient augen texture to some of the rocks. The foliation is defined by micaceous minerals or amphibole, depending on the original composition of the rock. The incipient augen texture is expressed by foliation bending around small, several mm in length, ellipsoid-shaped rock fragments. Where a fault passes through an outcrop of intermediate to felsic metavolcanics, an extremely hard, banded siliceous fine-grained rock results. In other parts of the area, the intermediate to felsic metavolcanics exhibit an ill-defined penetrative foliation. Coarser fragments in the pyroclastic rocks are elliptical in shape, presumably due to tectonic deformation. It is therefore difficult to reconstruct original fragment shapes from observed shapes. An indication of fragment sizes as observed on outcrop may be obtained from the three fold subdivision of the pryoclastic rocks (see legend on Map 2408).

Flow contacts are visible in only a few localities, one example, occurs about 1.5 km south of the end of the prominent peninsula in the western part of Hewitt Lake where a flow lies between sedimentary rocks and pyroclastic rocks. The base of the unit is in sharp contact with the metasediments; however, no flow-top breccia was present, and the top of the unit could not be precisely delineated.

Bedding is visible in some outcrops of pyroclastic rocks. As grain size becomes smaller, the greater is the likelihood of seeing bedding. In some localities, for example, just east of the eastern end of Hewitt Lake, bedding in the tuffs may be only a few millimetres to centimetres thick; in these cases, it is difficult in the field to decide whether the rock is a finely bedded siliceous pyroclastic metavolcanic or a recrystallized metachert. Bedding observed in lapilli-tuff exceeds 0.3 m in thickness. Graded bedding was seldom observed in the pyroclastic rocks; an example is present about 1800 m south of the prominent peninsula in the western part of Hewitt Lake.

Five flow rocks examined in thin section are revealed to be microporphyritic. The size of the microphenocrysts varies, from 0.3 mm to 2 mm, the ratio of phenocrysts to matrix varies from 1:20 to 1:3. A study was not made by the author of any variations in grain size of microphenocrysts or ratio of microphenocrysts to matrix that might exist in any one flow.

Feldspar microphenocrysts are present in all the rocks; from chemical staining the feldspar was identified as plagioclase. Plagioclase is altered to carbonate, sericite, and epidote; its original composition is not known. Granulated elliptical quartz phenocrysts are present in one sample from south of the South Bay of North Spirit Lake. Relicts of high temperature bi-pyramidal quartz were not observed, these were probably recrystallized. The matrix of all the samples consists of the following: very fine grained plagioclase (0.02 mm in diameter) which was identified by chemical staining, quartz, brown or green biotite, and accessory amounts of carbonate, opaque minerals, sericite or muscovite, and epidote. No potassic feldspar was identified; the presence of muscovite in some of the rocks suggests that potassic feldspar may be present; at best, the volume of potassic feldspar would be small.

The composition of the tuff, excluding crystal tuff, lapilli-tuff, and tuff-breccia varies over a wider range than the flow rocks. Amphibole (green actinolite), not seen in any flow rocks, is present in some thin-sectioned samples of the pyroclastic rocks which have a greenish colour on exposed surfaces. Quartz and muscovite are more plentiful in the pyroclastic rocks than in the flow rocks. Thus, the pyroclastic rocks are more mafic and more silicic than flow rocks.

Texturally, the tuffaceous rocks are little different in thin section from the flow rocks except for the presence of lithic fragments in the pyroclastic rocks. The matrix of the pyroclastic rocks is similar to that of the flow rocks; it is fine grained, crystals are about 0.02 mm in diameter, and composed mainly of plagioclase, quartz, biotite, actinolite, epidote, carbonate, and opaque minerals. The lithic clasts, many of which are flattened wispy fragments are similar to the matrix in composition. Presumably these fragments were originally glassy, and then were recrystallized; they have the same mineralogy and texture as the matrix in which they are set. Fragments more felsic or mafic than the matrix are more easily recognized. The more felsic fragments are usually quartz rich; but the more mafic fragments, although having obliterated outlines, are usually preserved as clumps of biotite and opaque minerals, or actinolite and opaque minerals.

A textural feature observed in thin sections of some pyroclastic rocks and not observed in the flow rocks, is the reaction between plagioclase grains and matrix, so that it may be impossible to precisely delineate the original shape of a plagioclase grain. This is not a metamorphic reaction; otherwise it would be observed throughout rocks of similar composition. It is probably an original feature of the rock, plagioclase crystals reacted with hot ash during and after aerial transportation and deposition, or perhaps during or after deposition from an ash flow.

Crystal tuff is intermediate rather than felsic in composition. As previously noted, these rocks can be confused with intermediate intrusive rocks in the field. Over the course of two field seasons, no satisfactory field method for distinguishing the two rocks types was devised by the field party. In thin section, plagioclase is revealed to be the dominant rock component and forms at least 75 percent of the rock. In two out of four thin-sectioned samples, plagioclase was sufficiently well preserved to be identified as An_{35} (andesine). Oscillatory, tending towards normal zoning of plagioclase, appears to be characteristic of these rocks. Photo 4 shows one of the more spectacular examples. Grain size of the plagioclase varies from about a centimetre down to about 0.3 mm. Plagioclase is generally altered; carbonate is an alteration product of plagioclase in all examples examined by the author. Biotite (5 to 10 percent) is present, and

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Photo 4–Photomicrograph of crystal tuff. The plagioclase phenocryst is strongly zoned and set in a fine-grained quartzofeldspathic matrix. Field of view is 2.5 mm.

epidote, sphene, and carbonate constitute the remainder of the rock as well as quartz (as much as 10 percent), actinolite (as much as 10 percent), and sericite (0 to 5 percent). Lithic clasts similar in composition to the matrix occur in these rocks, but are subordinate in amount to plagioclase. The matrix of these rocks is equigranular, with an average grain size of 0.04 to 0.05 mm which is coarser than the matrix in the other pyroclastic rocks and the flow rocks.

Metasediments

CLASTIC METASEDIMENTS

Terminology

All the Precambrian sedimentary rocks of the Hewitt Lake area have been metamorphosed.

In this report, the metasediments have been subdivided, in accordance with size limits proposed by C.K. Wentworth (1922), into three classes; conglomerate, sandstone, and mudstone based on the predominant size of the epiclastic fragments in the rock.

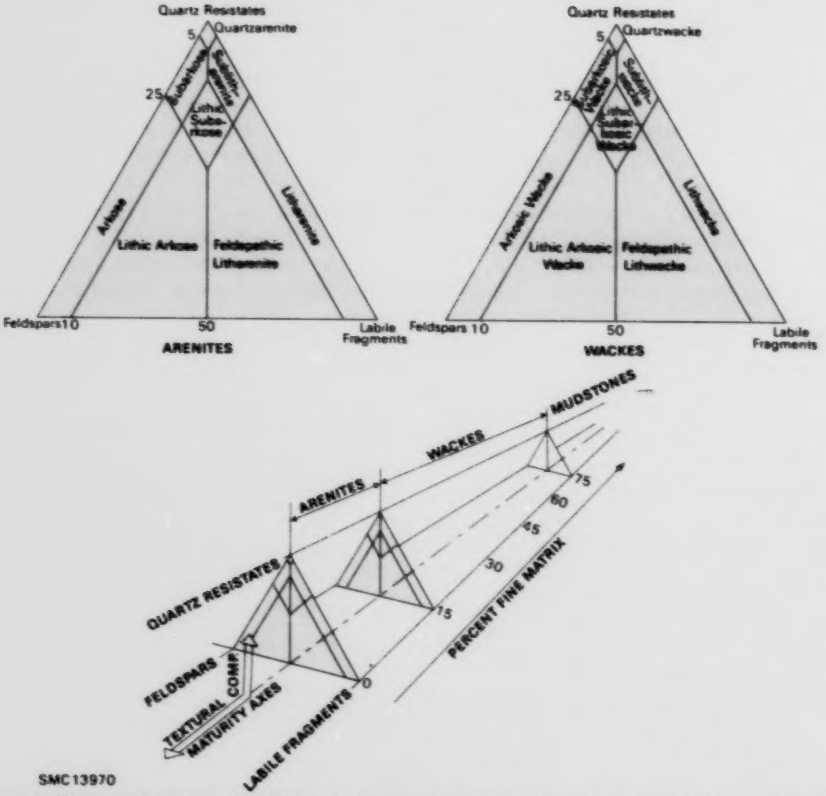
Quartz Resistates
5
Quartzarenite
Subarkose
Sublitharenite
25
Lithic Subarkose
Arkose
Litharenite
Lithic Arkose
Feldspathic Litharenite
Feldspars 10
50
Labile Fragments
ARENITES
Quartz Resistates
5
Quartzwacke
Subarkosic Wacke
Sublithwacke
25
Lithic Subarkosic Wacke
Arkosic Wacke
Lithwacke
Lithic Arkosic Wacke
Feldspathic Lithwacke
Feldspars 10
50
Labile Fragments
WACKES
MUDSTONES
WACKES
ARENITES
QUARTZ RESISTATES
FELDSPARS
TEXTURAL COMP.
MATURITY AXES
LABILE FRAGMENTS
0
15
30
45
60
75
PERCENT FINE MATRIX
SMC 13970

Figure 5–Diagram illustrating classification scheme used for sandstones in the Hewitt Lake Area (after Williams, Turner, and Gilbert 1954; and McBride 1963).

Some aspects of the terminology used are a reflection of the particular characteristics of the rocks being studied. The granule size range, 2 to 4 mm, is included with the sandstones where the granular material occurs in association with sandstone and with conglomerate where it occurs with coarser clasts. Thus terms such as "lithic subarkosic wacke, granular and thickly bedded" and "boulder to granule orthoconglomerate" appear in the map-legend (see Map 2408, back pocket). The sandstones are classified according to the scheme shown in Figure 5, which is based on that of H. Williams, F.J. Turner, and C.M. Gilbert (1954) and McBride (1963). The maximum grain size limit for the detrital matrix of the rocks in the Hewitt Lake area was taken to be 0.06 mm. This contrasts with some of the accepted classifications; for example F.J. Pettijohn, P.E. Potter, and R. Siever (1972, p.159) chose 0.03 mm as the upper size limit. The author selected this size limit because the size of the matrix grains in the sandstones of the Hewitt Lake area range from 0.01 mm to about 0.05 mm; a limit set at 0.03 mm divides the matrix into two artificial classes.

Details of the terminology used in the threefold classification of the metasediments will be given in the introduction to the individual sections that describe rocks of the different classes.

Occurrence and Relationships

The clastic metasediments form an important constituent (about 60 percent) of the metavolcanic-metasedimentary sequence in the Hewitt Lake area. The variations in mineralogy, textures, degree of deformation, and metamorphic grade are great. The descriptions, and discussion of the metasediments in this report simplify a complex geology.

Conglomerates are most important along the northeastern margin of the North Spirit Lake Belt. Southwest of the western end of Makataiamik Lake about 1500 m of conglomeratic rocks is exposed; northwestwards, the thickness decreases to some 200 m near Opwagan Lake. Conglomerates are found only locally in other parts of the map-area.

The arenaceous metasediments were volumetrically the most important class of metasediments, and show no preferential development in any one part of the area. Southwest of Makataiamik Lake, these rocks are interbedded with conglomerates and become more plentiful upwards in the section and along strike to the south.

Argillaceous metasediments are not plentiful within the map-area, and are developed only locally. In general, these rocks show an antipathetic relationship to the conglomeratic rocks, and occur in the interior parts of the North Spirit Lake Belt more distant from the granitic contacts.

Inevitably where epiclastic and pyroclastic rocks occur in the same "greenstone" belt an overlap of the depositional environments for the different rock types occurs; this makes mapping of these rocks difficult. Metasediments in the North Spirit Lake Belt contain much detrital sand-sized quartz. During field mapping, metasediments having abundant sand-sized quartz or a variety of lithic clast compositions were mapped as epiclastic rocks. These two criteria stand up well during thin section study. It was found that the epiclastic field classification was rarely changed as a result of laboratory study; several times rocks mapped as pyroclastic rocks were subsequently found upon laboratory examination to be epiclastic.

An aspect of this problem in the map-area is the distinction of thinly bedded fine-grained siliceous ash from thinly bedded epiclastic siliceous silt and/or chert. Thin section examination does not always resolve this problem, because in the localities where these rocks occur they are metamorphosed, and felsic volcanic clasts in the ash are recrystallized; the changed mineralogy and texture are similar to those of the siliceous silts.

Most clastic metasediments are located a sufficient distance away from granitic contacts to have been metamorphosed only to lower greenschist facies rank. Those metasediments located near the Margot Lake granitic body have been metamorphosed to a high grade, sillimanite is a common metamorphic mineral. This degree of metamorphism contrasts with the preservation of clastic clinopyroxene in a conglomerate west of Makataiamik Lake.

Most of the sedimentary rocks southwest of the western arm of Hewitt Lake have been sheared. Throughout the rest of the map-area, shearing is only local. All the metasediments within the map-area are foliated.

The metasediments south and west of Makataiamik Lake are characterized by fuchsite (a green muscovite). The green colour is derived from chromium which was confirmed to be present in the mineral structure by X-ray and spectrographic analyses carried out by the Geoscience Laboratories, Ontario Geological Survey, on mineral separates of a sample collected by the author.

Conglomerates

Conglomeratic rocks can be subdivided into orthoconglomerate and paraconglomerate. In an orthoconglomerate, the large clasts touch one another, thus the rock is clast-supported. In a paraconglomerate, the large clasts do not touch, thus the rock is matrix-supported. The grain size of the matrix in conglomerate gives an indication of depositional conditions. A paraconglomerate with pebbles and cobbles set in a sandstone matrix can be formed by traction currents in a fluvial environment, however, a pebble and cobble paraconglomerate with a matrix of mudstone can be deposited only from a medium capable of simultaneously transporting large and very small fragments, namely a density current, for example a turbidity current, or a glacier.

Field mapping of conglomerates such as those within the map-area, can give rise to inconsistencies in nomenclature, particularly in the distinction of paraconglomerate from orthoconglomerate. The author has not examined all the outcrops mapped in the area, and since it is difficult to representatively sample the conglomerates, some descriptive variation may exist in the report and on the map (Map 2408, back pocket).

Conglomerates can also be classified on the basis of the framework-clast composition. Rocks with only one rock type in the framework are oligomictic, and those with a number of rock types in the framework are polymictic. All the conglomerates in the map-area are polymictic.

Polymictic Conglomerates with an Arenaceous Matrix

The rock types included in this section have been grouped together because they are spatially, lithologically, and genetically similar.

Most of the conglomerates occur within 2.4 km of the northeastern contact between the North Spirit Lake Belt and the granitic rocks. There is a decrease in size of the framework clasts in a southwesterly direction away from the northeastern contact. The conglomerates in the central part of the map-area, except for one near the eastern end of Hewitt Lake have clasts in the pebble to granule size ranges.

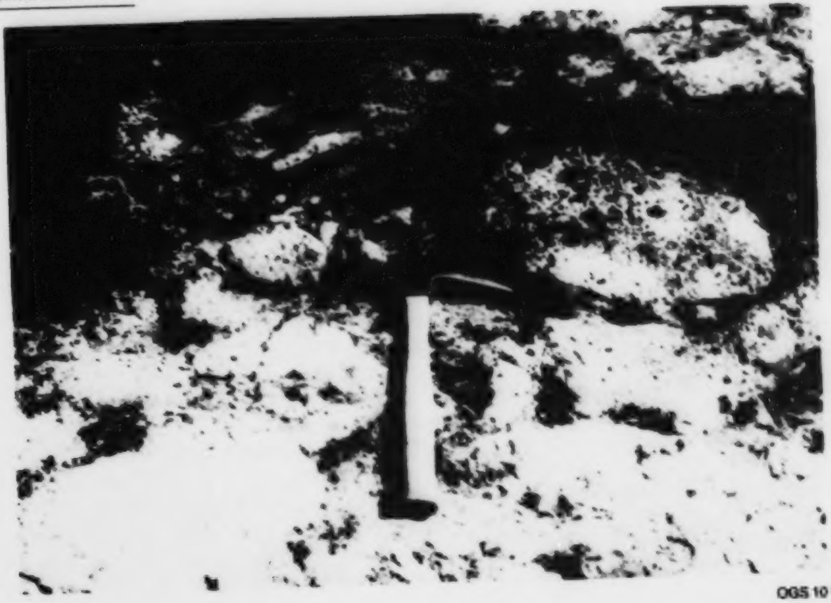

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Photo 5–Boulder to granule orthoconglomerate with an arenaceous matrix. Felsic clasts are readily apparent, but mafic clasts can be outlined only with difficulty. Most of the granitic clasts are well rounded. The hammer handle is 33 cm long.

Boulder to Granule Orthoconglomerate With a Wacke-Mudstone Matrix

Wherever the author has seen the basal part of the epiclastic sequence within the map-area (see section on "Stratigraphy"), a polymictic boulder to granule orthoconglomerate with an arenaceous matrix has constituted the basal rock type. Apart from that particular stratigraphic position, this rock type occurs only locally, that is on an outcrop scale within the map-area. Some of the best exposures of the rock type are on the western shore of Opwagan Lake and about 1.6 km northwest of the northwestern end of Makataiamik Lake where the conglomerate overlies, apparently unconformably (see section on "Stratigraphy"), ultramafic rocks.

Clasts are variable in size, but have a maximum diameter as exposed on outcrop surfaces of about 50 cm (Photo 5). Most of the larger framework clasts are apparently well rounded and spherical, although some are poorly rounded with a low sphericity. On vertical or steeply inclined outcrop surfaces it can be seen that the framework clasts have been extended in an approximately vertical direction by a factor of about two or three times the horizontal dimensions. It is therefore difficult to reconstruct the original shape of any one framework clast. The framework clasts which are obvious on the weathered outcrop surface and in a photograph (Photo 5) are the felsic fine-grained volcanic, and coarse-grained granitic clasts. These clasts weather out of the rock, are light coloured, and generally constitute the largest clasts in the rock. They were used for dimensional descriptions. Clasts of fine-grained mafic rock, presumably mafic metavolcanics, form a prominent constituent of the framework, but appear to have been more susceptible to deformation than the felsic clasts. These mafic clasts appear to have been flattened and extended to a greater degree than felsic clasts, and their boundaries are more difficult to define because they appear to merge with the matrix. In the upper part of Photo 5, the granitic framework clasts do not touch each other, the intervening framework clasts are mafic in composition, and clast boundaries can be defined only with difficulty. If the boundaries of the mafic clasts cannot be seen on the weathered outcrop surface, then the rock will appear to be a paraconglomerate.

The colour of the weathered surface of the conglomerate matrix may be dark brown, grey, or dark green. In thin section, the conglomerate matrix is revealed to be poorly sorted. The larger sized matrix clasts are on average 1.5 to 2.0 mm in diameter, but clast diameters up to 5 mm were noted; the fine-grained matrix material, less than 0.06 mm in size, has an average grain size between 0.03 mm and 0.06 mm. Sphericity and roundness of the sand-sized clasts vary widely. The composition of the conglomerate matrix is variable, hence the different weathered colour, as a rule, the more felsic the matrix, the lighter the colour. The dark green varieties are usually amphibole rich. Lithic fine-grained quartzofeldspathic fragments, felsic metavolcanics, were noted in some thin sections. No fragments of mafic rocks were noted, but in three thin sections point-counted, as much as 20 percent of the fine-grained matrix is amphibole and/or biotite and chlorite.

Matrix Modification in the Boulder to Granule Orthoconglomerate

It was noted in the preceeding section that on outcrop, mafic framework clasts appear to be more deformed than adjoining felsic framework clasts. Also, mafic framework clasts appeared in some instances to blend into the conglomerate matrix. Thin sections reveal that this same effect is present in the matrix of the conglomerate.

Modal analyses such as those given in Table 3 show that quartz and feldspar are the important sand-sized components of the conglomerate matrix, whereas ferromagnesian minerals are the most important silt- and clay-sized components. These properties are to be expected because of the greater ease with which ferromagnesian minerals can be broken down chemically and physically as compared to felsic minerals; nevertheless, in little deformed samples such as Sample W-73-54 (Table 3) sand-sized lithic (including mafic) clasts are recognizable. In the majority of the sand-sized lithic clasts, the grain size of the constituent minerals falls in the range 0.01 to 0.06 mm. Progressive steps in the modification of sand-sized clasts from those which probably approach their original shape to those which are represented by diffuse clumps of silt and clay-size minerals are recognizable in different thin sections.

Examination of thin-sections of metavolcanics indicates that at the lower

TABLE 3 MINERAL FREQUENCY ANALYSES OF CONGLOMERATE MATRIX. COLUMNS 1, 3 AND 5 PROVIDE RAW DATA; THE UPPER PARTS OF COLUMNS 2, 4 AND 6 REPRESENT FRAMEWORK ANALYSES RECALCULATED TO 100 PERCENT (IN ROUND FIGURES); THE LOWER PARTS OF COLUMNS 2, 4 AND 6, REPRESENT TOTALS OF FRAMEWORK AND FINE MATRIX. THE LETTERS AFTER THE SAMPLE NUMBERS REFER TO FIGURE 6.

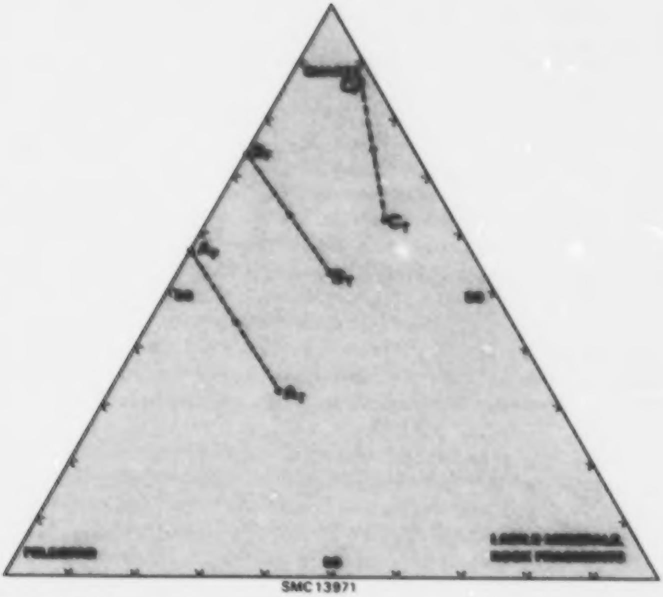
Sample Number	W-73-45(B)		W-73-41(A)		W-73-54(C)	
Column	1	2	3	4	5	6
SAND-SIZE CLASTS						
		Recalculated to 100		Recalculated to 100		Recalculated to 100
Quartz	45.4	74	27.8	57	58.1	88
Feldspar	15.8	26	20.8	43	0.5	1
Lithic clasts	—	—	—	—	7.2	11
SILT- AND CLAY-SIZE CLASTS						
		Totals		Totals		Totals
Quartz	6.8	52.2	4.4	32.2	4.1	62.2
Feldspar	8.8	24.6	20.8	41.6	10.0	10.5
Biotite-chlorite	5.5	32.2	—	26.2	17.0	27.3
Amphibole	15.5		20.2		—	
Epidote	2.2		6.0		3.1	
Opaque minerals, and sphene						

greenschist facies metamorphic rank of most of the rocks in the Hewitt Lake area, the resultant grain sizes fall largely in the 0.01 mm to 0.06 mm range. The author considers that at least some, and possibly much, of the silt- and clay-sized component of a conglomerate matrix has been derived by deformation and metamorphism of originally metavolcanic sand-size grains. These grains prior to deformation and metamorphism may have been either glass or fine-grained crystalline rocks.

Due to this matrix modification, the rocks appear to be texturally less mature but are compositionally more mature (see Figure 5). The post-depositional change in texture is a result of sand sized grains becoming silt and clay sized; that is the apparent amount of fine in the rock increases.

The increase in compositional maturity is illustrated in Figure 6. Rocks A, B, and C, the mineral frequency analyses of which are given in Table 3, all have more than 15 percent matrix and when plotted with their sand-sized grains recalculated to 100 percent, plot at positions A_F, B_F, and C_F in Figure 6.

Since the apparent silt- and clay-sized parts of the rocks exceed 15 percent, all the rocks appear to be wackes. Plot A_F represents an arkosic wacke, B_F an



SMC 13971

Figure 6–Triangular diagram showing compositional analyses of the matrix of three boulder to granule conglomerates. Letters refer to analyses given in Table 3 (see section on "Matrix Modification in the Boulder Orthoconglomerate" in text).

arkosic wacke, and C_F a sublithwacke. All of the silt and clay size components in these rocks were probably initially sand-size; that is the rocks were texturally more mature arenites. The rock compositions would then plot at positions A_T, B_T, and C_T on Figure 6 and be in the arenite field of Figure 5; these are positions of greater compositional immaturity than A_F, B_F, and C_F which plot in the wacke field of Figure 5. This assumption is extreme, actually the original rock compositions of rocks A, B, and C probably lay somewhere along the lines A_F to A_T, B_F to B_T, and C_F to C_T respectively, since some silt- and clay-sized fragments almost undoubtedly were present in the original sediment.

The classification system used in this report was designed primarily for sediments rather than metasediments. It assumes that the components in the fine fraction of a rock cannot be identified.

The mineralogy of the fine-grained part of the metasediments in the map-area can be identified when the feldspars are stained so that they can be distinguished from quartz. The author therefore considers that the matrix for a conglomerate from within the map-area can be more accurately described by the following: a) assessing the amount of material less than 0.06 m and thereby describing the rock as a wacke or arenite; b) using the total mineralogical point count to give the rock its name.

On this basis, rocks A, B, and C (Figure 6) are a lithic arkosic wacke, lithic subarkosic wacke, and feldspathic lithwacke respectively.

Cobble to Granule Orthoconglomerate, Boulder to Granule Paraconglomerate with an Arenaceous Matrix

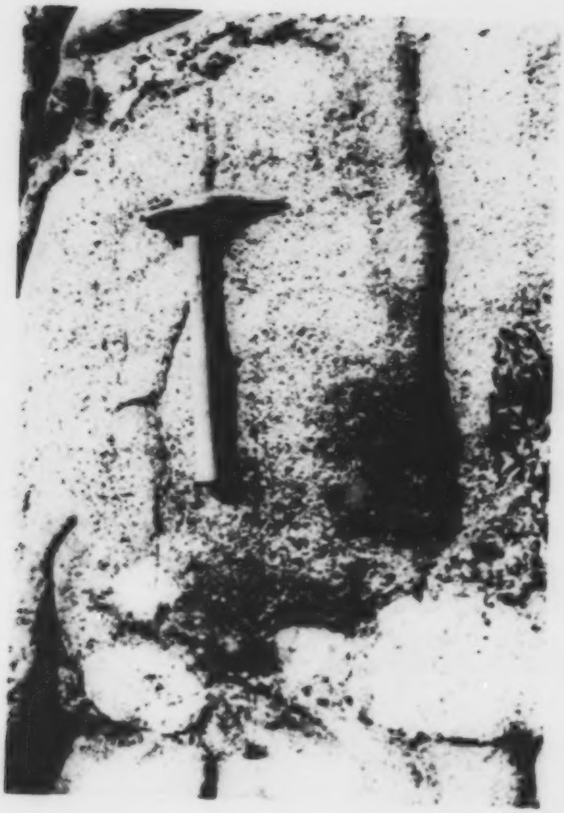
These two rock types form a common association in the map-area, and represent steps in the reduction of the size and density of packing of framework clasts between the boulder to granule orthoconglomerate just described and the granular, thickly bedded, arenaceous metasediments described below. The boulder to granule orthoconglomerate just described, with which the cobble to granule orthoconglomerate is sometimes interbedded, is very thickly bedded, the bed thickness is usually greater than 3 m and often exceeds the size of an outcrop. In contrast, the cobble to granule orthoconglomerate occurs in beds which are usually small enough to be recognizable on outcrop, but may reach a maximum thickness of several metres, the minimum thickness is a few centimetres. The boulder to granule paraconglomerate occurs in beds which seldom exceed 1.8 m in thickness and which have a minimum thickness of several centimetres.

Boulders are not present in all occurrences of the paraconglomerate examined; in the central and western part of the North Spirit Lake Belt, pebble- and granule-sized clasts are most common. These two conglomerate types are best developed in the clastic metasedimentary sequence southwest of Makataiamik Lake and show a decrease in coarse clast size with increasing stratigraphic height so that the upper parts of the sequence generally contain only pebbles and granules.

The most spectacular aspect of the conglomerate visible on the weathered surface is the grain size gradation in individual beds. Sometimes, a bed composed of boulder or cobble conglomerate at the base can be composed of sandstone at the top. Photo 6 illustrates a bed containing cobble size clasts at its base grading upwards through pebble conglomerate to granular sandstone. The overlying bed can be seen at the top of the photograph. The apparent subparallel attitude of the bases of the beds is not a function of photographic perspective, but is typical of the contacts seen throughout much of the sequence southwest of Makataiamik Lake. Channel structures are common; not infrequently on an outcrop area where, say six beds are exposed, none of the beds will have a similar strike direction. Because of the erosional nature of the sedimentary processes in this sedimentary sequence, it is possible that the uppermost parts of many of the conglomerate beds have been removed. Some of the graded beds are boulder to cobble orthoconglomerate at their bases and paraconglomerate in which clasts up to 25 cm in diameter are set in a sandstone matrix close to their tops.

Photo 7 illustrates another characteristic seen in some of the conglomerates in the sequence southwest of Makataiamik Lake. Many of the clasts are large and the framework clasts increase in size away from the base of the bed, showing that the lower part of the conglomerate bed is inversely graded. There are no large framework clasts stratigraphically above those visible in the photograph; no apparent break exists within the bed, and the upper part of the bed is a pebbly to granular sandstone becoming finer upwards.

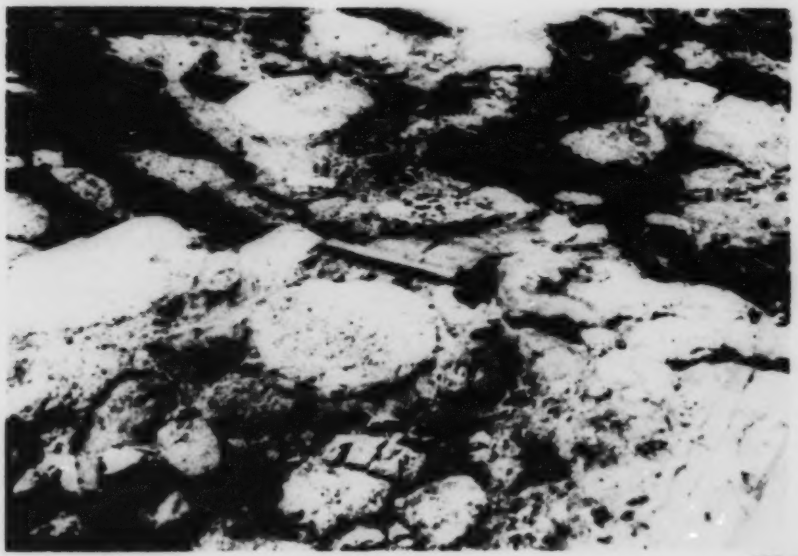
In the boulder to granule orthoconglomerate in the lowermost part of the metasedimentary sequence near Makataiamik Lake, mafic and felsic metavol-



OGS 10 159

Photo 6–Conglomerate bed with cobble-size clasts at base, grading upwards through pebble conglomerate to granular sandstone. The hammer handle is 33 cm long.

canics are the only intrabelt rock types present in the clast population. A characteristic feature of the two conglomerates being discussed, particularly at the stratigraphic levels where they first appear in the rock sequence, and where they are interbedded with the boulder to granule orthoconglomerate, is that the framework clasts represent a variety of rock types from within the North Spirit Lake Belt. Clasts of iron formation and chert are common, and in one outcrop, a field party member observed a clast of conglomerate in a conglomerate bed. Pebbles of granitic material, felsic metavolcanics, and quartz are also present. Mafic clasts are found only locally; for example near the small lake between Wokokotai Lake and Hewitt Lake. In some isolated localities there are conglomerates which are almost oligomictic; for example the coarse size fraction of a conglomerate on the southern shore of the eastern arm of Hewitt Lake is formed mainly of chert pebbles, the remainder being felsic metavolcanics.



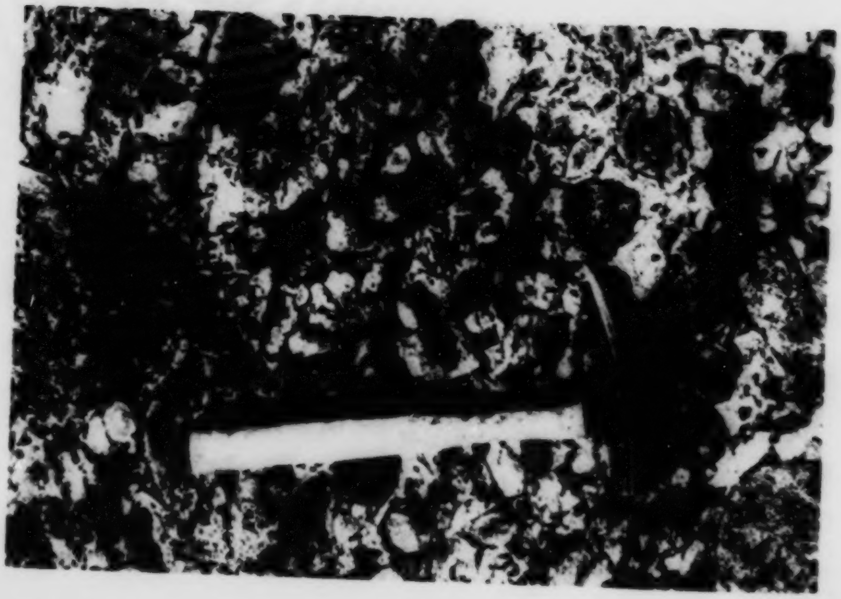
OGS 10 160

Photo 7–Conglomerate bed showing apparent inverse grading. The top of the bed is to the left of the photograph. The hammer handle is 33 cm long.

The conglomerates near the western end of Hewitt Lake are strongly sheared, and only felsic fragments were recognized.

The colour of the conglomerates may vary from bed to bed and place to place. The weathered surfaces and the fresh surfaces are usually light coloured, but may be brown, grey, or green. The colouration is a function of the proportions of felsic to mafic clasts and the matrix composition; a conglomerate with quartz and felsic metavolcanic framework fragments and a quartzofeldspathic matrix is light coloured, whereas one with a mixture of felsic to mafic framework fragments and an amphibolitic matrix is darker and green to brown.

The matrix of any conglomerate bed within the area irrespective of composition or location has one consistent quality; a grain size bimodality. The grain size of the coarser fraction varies from bed to bed, but is generally within the range of 0.3 to 3 mm; the fine-grained fraction is always between 0.01 mm and 0.05 mm. Quartz and altered plagioclase are present in both size fractions. The only rock fragments which can be identified are felsic metavolcanics. Clumps of biotite and actinolite in some samples presumably represent recrystallized mafic rock fragments. After visual inspection of thin sections, the matrix of any one conglomerate bed can be classified as either lithic arkosic wacke, or lithic subarkosic wacke.



OGS 10 161

Photo 8–Boulder to granule orthoconglomerate with feldspathic lithwacke matrix. The contrasting populations of clasts (felsic to ultramafic) are apparent. The hammer is 33 cm long, the photograph does not include any of the largest fragment sizes.

Boulder to Granule Orthoconglomerate with Feldspathic Lithwacke Matrix

This rock type was found in only one part of the map-area 2100 m west-northwest of the western end of Makataiamik Lake, and is distinctive on outcrop primarily because of its black and white colour (Photo 8). The black colour was derived from mafic and ultramafic framework rock fragments and the matrix, and the white colour was derived from clasts of felsic rocks such as felsic metavolcanics, chert, granitic material, aplite, and quartz. All of the framework clasts are well rounded as seen on horizontal outcrop surfaces, and range from about 0.3 m to a few mm in length with a size mode around 7.6 cm. Thin section examination reveals that the conglomerate matrix ranges in grain size from about 0.02 mm up to about 0.5 mm, and consists of plagioclase (generally albitic), quartz, actinolite, clinopyroxene, carbonate, sphene, and opaque minerals. Malachite, azurite, magnetite, and chalcopyrite were identified by the author. For a discussion of the origin of this conglomerate see the section entitled "Stratigraphy".

Hewitt Lake Area

Polymictic Conglomerate With an Argillaceous Matrix

Conglomerates with an argillaceous matrix are not abundant within the map-area. There are outcrops of these rocks between the western end of Makataiamik Lake and Opwagan Lake, and several outcrops, mostly at the higher stratigraphic levels in the conglomerate sequence southwest of Makataiamik Lake.

Boulder to Cobble Paraconglomerate Argillaceous Matrix

Outcrops indicated on the map as paraconglomerate with argillaceous matrix occur between Opwagan Lake and Makataiamik Lake, and were not examined by the author. Framework clasts noted on these outcrops were granitic material, chert, and felsic metavolcanics.

The paraconglomerates in exposures southwest of Makataiamik Lake are composed primarily of pebble-sized clasts of granitic material, chert, ferruginous chert, vein quartz, and mafic-intermediate rock fragments set in a matrix marginal between wacke and mudstone.

Sandstones

The distribution of sandstones within the map-area is outlined in the section on "Terminology of the Clastic Metasediments".

The sandstones in the northeastern half of the North Spirit Lake Belt have a low metamorphic grade and can be classified in the quartz-albite-muscovite-biotite-chlorite subfacies of the Abukuma-type facies series (H.G.F. Winkler 1967; see section on "Metamorphism"). In the southwestern half of the North Spirit Lake Belt, within the Hewitt Lake area, the metamorphic grade varies from the subfacies just mentioned up to the sillimanite-cordierite-orthoclase-almandine subfacies of the Abukuma-type facies series. The highest grade metasediments occur just to the south of Margot Lake, and form part of the high grade metamorphic rocks lying within approximately 0.8 km of the Margot Lake granitic body. Other isolated occurrences of high grade metasediments occur in the map-area. For instance, 1.2 km east of the eastern extremity of Hewitt Lake, there is an occurrence of andalusite-muscovite schist.

Variations in metamorphic grade within the map-area cause compositional and textural changes in the sandstones, and introduce factors which complicate the determination of the original character of a rock. Sandstones in the metasediments near Margot Lake were metamorphosed under conditions of the sillimanite-cordierite-orthoclase-almandine subfacies of the Abukuma-type facies series (Winkler 1967). These rocks were recrystallized and are almost equigranular; no evidence of the shape and size of original fragments especially rock fragments remains, and no original textures with the exception of bedding are preserved. In most parts of the map-area sandstone was metamorphosed under low grade metamorphic conditions such as the quartz-albite-muscovite-biotite chlorite subfacies of the Abukuma-type facies series. Lithic fragments in these rocks, particularly fragments of felsic metavolcanics are recrystallized and may be difficult to distinguish from feldspar grains particularly in hand samples of the finer grained sandstones.

As well as the textural problems just mentioned and the problem of sand-sized clasts being incorporated into fine-grained matrix (see section on "Matrix Modification", other lesser textural problems occur. In parts of the map-area, for instance near the western contact of the metasediments with the granitic rocks where there has been extensive cataclastic deformation, bedding characteristics may be obscured; also, some outcrop areas are too small for outlining bedding thicknesses.

The colour of the sandstones within the map-area is variable. The colour of any sandstone unit is usually a general guide to its composition; fine-grained units are darker than coarse-grained ones of similar composition. Rock units with a high content of mafic minerals or mafic rock fragments are dark green-brown on the fresh surface, and dark green on the weathered surface. Quartz arenite is white or light grey coloured on weathered and fresh surfaces. Rocks with compositions between these extremes have colours on weathered surfaces between dark green and white, and include grey, and various shades of brown, buff, and light green.

During the mapping of the arenaceous metasediments, an attempt was made to classify the rocks exposed on outcrop according to composition and to primary texture. Due to the problems outlined above, a degree of latitude exists in the field nomenclature of the sandstones.

Sedimentary Structures

In the sandstones within the map-area, individual beds may differ greatly in thickness from one another, the maximum observed bed thickness is in the order of 6 m, minimum bed thickness is in the order of a few centimetres. The legend on the accompanying map (Map 2408, back pocket) indicates whether a wacke is; thickly bedded, bedding greater than about 45 cm thick; medium bedded, bedding between 45 cm and 10 cm thick; or thinly bedded, bedding is less than 10 cm thick. Arkose, subarkose, and quartz arenite are medium bedded, as are most of the observed graded units, although some are thinly bedded. The general distribution of bed thicknesses can be obtained from Map 2408 (back pocket) A general relationship exists between bed thickness and grain size; the coarser grained sandstones are usually medium to thickly bedded, and the more argillaceous sandstones are thinly bedded.

Channel structures are common in some parts of the map-area particularly southwest of Makataiamik Lake. The sides of a channel are the most easily identifiable part of the structure. Recognition of channels is dependent on outcrop size and quality, for if a channel is larger than an outcrop area, it will not be readily identifiable. In Photo 9, a channel infilled by sandstone can be seen just to the left of the hammer head. Bedding is visible in the unit underlying the channel sandstone. Consequently the typical gouging effect of a channel

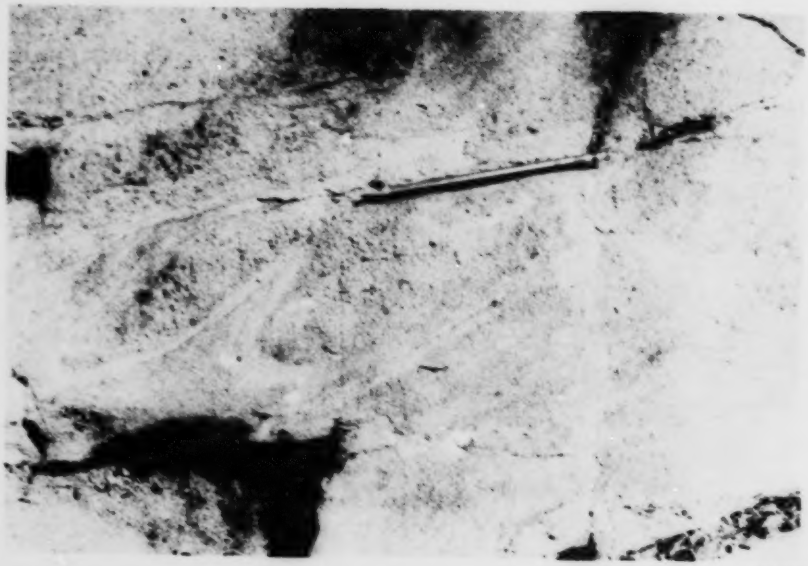
OGS 10 162

Photo 9–Interbedded sandstones showing part of a channel structure. Note the parallelism of the beds underlying the conglomerate at the left of the photo with the beds to the right of the photograph. The hammer handle is 33 cm long.

is not readily apparent. The outcrop area adjacent to the area visible in the photograph contains many channels ranging in width from less than 1 m to greater than 7 m, the outcrop width. Channel infillings are not restricted to sandstone, but frequently include conglomerate. The channels could be mistakenly interpreted as crossbeds in a small outcrop area where a number of sandstone infilled channels intersect. Intersecting channels provide reliable stratigraphic top determinations in contrast to the graded conglomerate units (see section "Cobble to Granule Orthoconglomerate, Boulder to Granule Paraconglomerate With an Arenaceous Matrix").

Flame structures common in the sedimentary sequence southwest of Makataiamik Lake are less common in other parts of the map-area. This observation again may be a function of outcrop size and quality. Photo 10 illustrates a flame structure located in a small outcrop some 4 km north of the western end of Hewitt Lake.

Sole markings having a definite sedimentary origin have not been seen by the author. Structures which could be interpreted as sole markings have been observed, but are probably tectonic.



OGS 10 163

Photo 10–Flame structures in arenaceous beds. The pencil is 18 cm long.

In the map-area, the most common internal sedimentary structures are those which can be correlated with the parts of a typical Bouma sequence (Bouma 1962) and are shown in Figure 7. Complete Bouma cycles were recognized only locally in the metasedimentary sequence south of Makataiamik Lake. The most commonly observed part of a Bouma sequence is the graded "A" interval. The lower two intervals and occasionally the three lower intervals were observed.

Dish structure (Photo 11) was recognized locally in sandstone of the metasedimentary sequence southwest of Makataiamik Lake. It is present in the massive part of a sandstone bed in a position equivalent to the "A" subdivision of a Bouma sequence.

Quartz Arenite, Arkose-Subarkose, Lithic Arkose

These rock types are grouped together because they are: 1) arenites, and 2) quartz- and feldspar-rich, and are inferred to be more mature than other sandstones in the map-area. The association of lithic arkose with quartz arenite and subarkose may at first seem incongruous, but the lithic fragments in the lithic arkose are composed of quartz and feldspar so that the rock is quartzofeldspathic like the other rocks.

On the weathered surface, these rocks are light coloured because of the affects of weathering on the feldspathic minerals and the feldspathic rock frag-

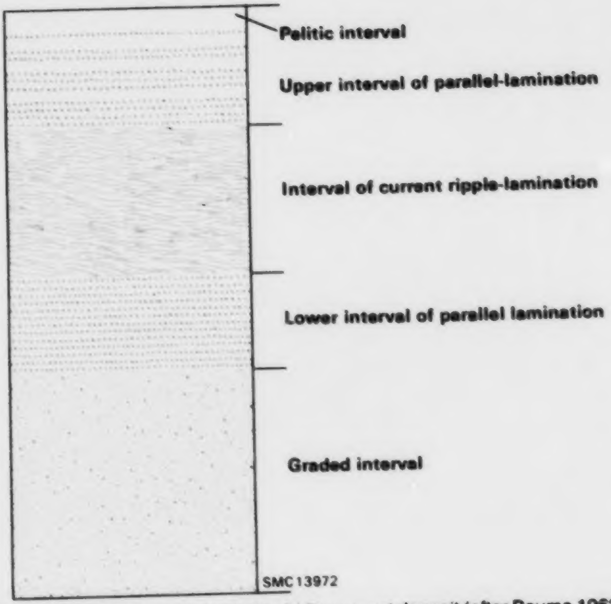

Pelitic interval
Upper interval of parallel-lamination
Interval of current ripple-lamination
Lower interval of parallel lamination
Graded interval
SMC 13972

Figure 7–Stratification of a typical turbidity current deposit (after Bouma 1962).

ments. On the fresh surface, the high quartz content imparts a grey colour to the rocks. In the field, difficulty was encountered in distinguishing felsic volcanic rock fragments from feldspar grains, especially in the finer grained rocks. All of these rock types are indurated and tough, and like all of the sandstones in the map-area, break across rather than around grains.

Quartz arenite occurs at the following three localities: just to the south of Hewitt Creek midway between Hewitt and Little Hewitt Lakes; about 2100 m north of the western end of Nipa Lake; and about 2700 m north-northwest of the western end of Makataiamik Lake. The occurrences in the western part of the map-area are similar; quartz arenite is massive and well cemented and outcrops with other mature (arkosic) metasediments. The occurrence northwest of Makataiamik Lake occurs on an isolated outcrop is not well cemented, is vuggy in appearance, and contains pyrite and pyrrhotite. The grain size in quartz arenite from the map-area varies from granule to silt size. The quartz-rich nature of the rock is distinctive in the field.

Two thin sections of samples of quartz arenite from the two western occurrences indicate that the rocks have undergone cataclastic deformation; original textures cannot be recognized. Quartz grains have been flattened, intergrain boundaries are sutured, and incipient polygonization has taken place. Apparent grain sizes range from about 0.02 mm to about 2.5 mm. Minerals constituting the rock are quartz, with subordinate muscovite, biotite, and garnet, and in one sample, minor quantities of feldspar.

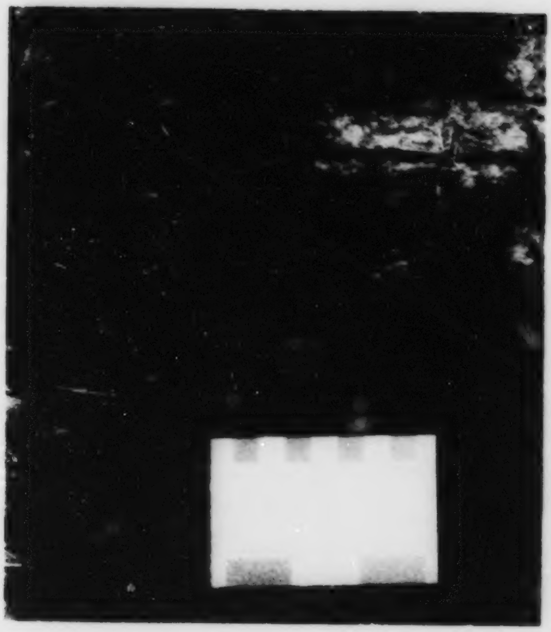


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Photo 11–Dish structures in sandstone part of a conglomerate-sandstone bed, southwest of Makataiamik Lake. The structure occurs in the graded interval below the parallel laminated part of the bed and above the inverse to normally graded conglomerate part, the top of which is just visible in the bottom of the photograph.

The arkosic-subarkosic and lithic arkosic rocks occur primarily in the Makataiamik Lake clastic metasedimentary sequence, although they do occur locally in other parts of the map-area underlain by metasediments. These rocks occur in the same localities as the quartz arenite mentioned. In one locality, just north of the western end of Hewitt Lake, these arkosic-subarkosic rocks form a distinct mappable rock unit. On weathered outcrop surfaces, such rocks are light coloured, the more feldspathic varieties are off-white. The colour of a fresh surface may be similar to that of the weathered surface, for example the unit near Hewitt Lake, or may be different from that of the weathered surface; for example in an occurrence northwest of Makataiamik Lake, the fresh rock surface is mainly black with contrasting white feldspar grains.

Bedding is generally present in these rock types; careful observation is sometimes required to recognize differences in grain size that indicate bedding directions. The limits of a bed are difficult to define in some cases, such as in the occurrence near Hewitt Lake. Grain sizes often extend into the granule-size class. Thin section examination reveals that the unit outcropping near Hewitt Lake and a unit some 2700 m south of the central part of Makataiamik Lake, have minor amounts of matrix material. Other samples have up to about

15 percent matrix constituted largely of quartz and feldspar in the size range 0.03 mm to 0.05 mm. The sand sized clasts form an intact, partly-welded framework with matrix-sized material enmeshed in framework gaps. Since there must have been a considerable amount of solution and recrystallization along grain boundaries to achieve the observed welding of sand-sized grains, any estimates of roundness or sphericity would be erroneous.

Table 4 contains mineral frequency analyses for an arkose (H-73-68(B)), a subarkose (H-73-82(A)), and a lithic arkose (W-73-31(E)).

The names applied to the latter of these rocks does not apparently conform to the rock classification outlined. For further details see section "Matrix Modification and Petrography of the Sandstones".

The analyses in Table 4 show that the rocks range from those rich in quartz to those rich in feldspar; no correlation has been observed between composition and stratigraphic position or paleogeographic position.

Lithic Arkosic Wacke, Lithic Subarkosic Wacke

These two rock types constitute most of the sandstone sequence within the map-area. The percentage of quartz in both rock types is similar, thus separation of the two types in the field, particularly where rock compositions are near a line of subdivision (see Figure 5), depends on distinguishing feldspar grains from felsic volcanic rock fragments. Such a separation was not possible because of the scale of mapping and the time available. There may be a complete gradation from one rock-type to another.

The rocks are wackes and have more than 15 percent apparent detrital matrix which can usually be recognized in the field. Associated with the textural change from arenite to wacke, which is a function of the increase in matrix content as compared to the arenites, there is a corresponding increase in the number of rock fragments in the rock framework. On the triangular classification diagram (see Figure 5), this change is represented as a movement from the top left-hand side of the triangle towards the central part of the triangle.

On the weathered surface, these rocks are generally buff to almost white, but may be brown, grey, or a number of intermediate colours depending on the composition of any one bed. Freshly broken surfaces may be brown, grey, green, or black. One occurrence about 1.5 km north of the northern end of Wokokotai Lake was initially thought to be volcanic in origin because of its jet black appearance on the fresh surface, the siliceous splintery nature of the rock, and its apparently microporphyritic texture. In another occurrence about 1.5 km southeast of South Bay, resampling and the cutting of several thin sections would be needed to clarify the origin of some of the siliceous rocks.

Bedding thicknesses are in the range outlined in the section on sedimentary structures. Generally, bedding can be seen with ease. In some localities, such as 1.5 km southeast of South Bay and 1.5 km north of the northern end of Wokokotai Lake, bedding could not be discerned on some outcrops of lithic subarkosic wacke.

TABLE 4 MINERAL FREQUENCY ANALYSES OF SANDSTONES, HEWITT LAKE AREA.

Sample Number	H-73-68(B)	H-73-82(A)	W-73-31(E)	W-73-21(J)	W-72-90(F)	H-73-84(G)	H-73-21(I)	H-73-39(D)	W-73-13(H)	W-73-52(C)
FRAMEWORK COMPONENTS:										
Quartz	58.0	81.6	26.0	8.8	40.4	45.4	3.4	52.4	15.2	51.4
Feldspar	25.0	3.8	55.4	46.4	23.3	10.8	44.8	6.3	23.8	8.6
Lithic Clasts	—	—	?	1.0	8.3	?	1.0	?	8.8	—
Amphibole	3.8	—	—	—	—	—	—	—	—	—
Epidote	13.2	—	—	—	—	—	—	—	—	—
Sphene + opaque minerals	—	—	—	—	—	—	—	—	—	—
MATRIX MINERALS:										
Quartz	—	0.2	2.6	22.8	5.4	6.8	32.2	8.7	14.2	6.4
Feldspar	—	4.4	9.4	6.6	6.0	3.4	7.8	13.9	14.0	20.6
Biotite-chlorite	—	—	3.2	10.6	16.6	9.6	chlorite 9.8 sericite	4.6	15.0	0.2
Muscovite-sericite	—	10.0	4.3	—	—	0.8			—	11.2
Epidote	—	—	—	3.8	—	12.2	1.0	2.8	—	1.2
Sphene + opaque minerals	—	—	0.1		—			tr	see carbonate	1.2
Amphibole	—	—	—	—	—	11.0	—	11.3	2.4	0.4
Carbonate	—	—	—	—	—	—	—	—	7.2 (includes opaques)	—
Rock Name	Arkose	Subarkose	Lithic-Arkose	Lithic Arkosic Wacke	Lithic Arkosic Wacke	Lithic Arkosic Wacke	Lithic Arkosic Wacke	Lithic Subarkosic Wacke	Feldspathic Lithwacke	Arkosic Wacke

Notes:
For an explanation of the rock names, see section on "Matrix Modification and Petrography of the Sandstones". Letters after sample number refer to samples plotted in Figure 8.

Abbreviation:
— - Not detected or not determined
Tr - Trace amounts detected only

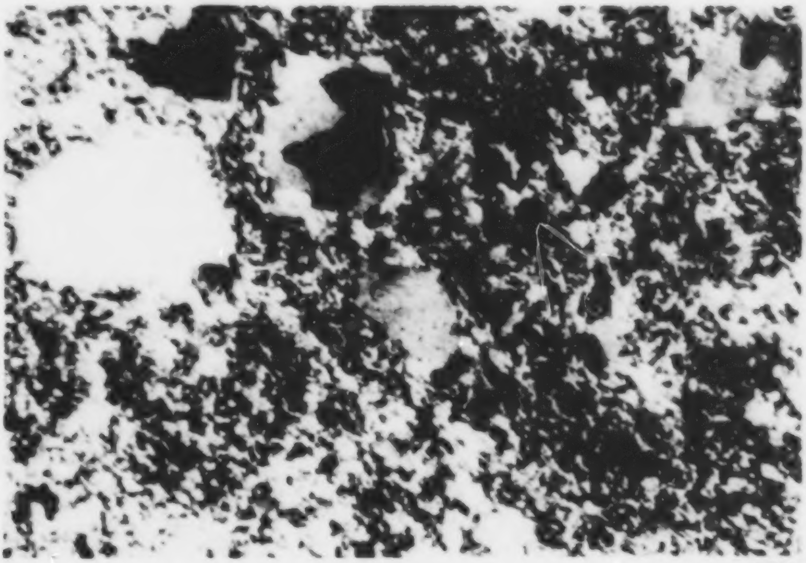

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Photo 12–Photomicrograph of lithic subarkosic wacke. Quartz and feldspar sand-sized clasts are set in a fine-grained matrix. Much of the fine-grained matrix may have been derived from lithic fragments. Field of view is 2.5 mm.

In thin section, arkosic wacke and subarkosic wacke are revealed to show a distinct bimodality in grain size distribution (Photo 12). The size of the coarser mode may vary somewhat depending on the coarseness of the framework, however, the fine grains invariably form a size mode from 0.03 to 0.05 mm, within a range from about 0.02 mm to 0.06 mm. All grain sizes were obtained from quartz or feldspar fragments; micaceous minerals are not suitable for grain-size analyses because of their morphology. In calculating the volume of the matrix in most rock samples, the micaceous minerals were included as detrital matrix. In some of the rock samples, it is apparent that some of the micaceous minerals had been derived from detrital grains, for example muscovite had been derived from feldspars and biotite had been derived from mafic rock fragments. In such cases, allowance was made in reconstructing the original framework/matrix compositions and amounts.

Of the 25 rock samples thin sectioned, none contained grains with consistently high values of sphericity and roundness. In any one sample some grains have high values, some low values, and the other values are spread between the extremes. Quartz grains were used for estimates of sphericity and roundness because they seem to have been less susceptible to deformation than any other clastic fragments. High values of sphericity and roundness may be due to other than sedimentary causes. For example, quartz, if initially idiomorphic, has an almost circular cross-section when viewed along the crystal length. All quartz grains sectioned in this way would have a low birefringence.

A relationship between roundness, sphericity, and birefringence did not appear to exist during the preliminary inspection of thin sectioned samples. At least some of the quartz grains with high sphericity and roundness are therefore deduced to be the product of extended involvement in sedimentary processes.

In all the 25 thin sections examined, the rock framework consists of quartz, feldspar (principally plagioclase), and rock fragments. The composition of the framework in the thin sections point counted varies from a quartz content of 89.3 percent (10.7 percent feldspar, sample W-73-39) to a feldspar content of 91 percent (6.9 percent quartz and 2.1 percent lithic clasts, sample H-73-21(1): Table 4). Estimates of the amount of rock fragments present as framework clasts range from a few percent to about 40 percent. Mineral frequency analyses of individual rock samples are given in Table 4.

Most feldspar grains, are plagioclase and due to the overall low metamorphic grade, have been altered to albite, epidote, sericite, and possibly also calcite. Potassic feldspar in the form of microcline was found in only a few rocks and in small amounts. For example, a lithic subarkosic wacke 2.4 km west of the "V" in Hewitt Lake contains traces of microcline and 0.8 km southwest of South Bay, an arkosic wacke also contains traces of muscovite (less than 5 percent).

Most of the lithic clasts are composed of felsic to intermediate volcanic fragments, although mafic metavolcanic fragments, fragments of subvolcanic intrusive rocks, and chert fragments were noted. The chert fragments were found only locally, near the small lake southwest of Wokokotai Lake where a lithic subarkosic wacke horizon occurs adjacent to a chert horizon. Sedimentary rocks containing fragments thought to be of subvolcanic intrusive rock are located in the vicinity of South Bay. The fragments are very similar to rock types in the Bijou Point Complex (Wood 1977) and may have been derived from that complex. Sedimentary rocks containing mafic metavolcanic clasts occur locally, and can be identified easily in the field because of the conspicuous nature of a mafic fragment in an essentially quartzofeldspathic rock. The chert-bearing wacke mentioned above also contains mafic rock fragments.

The matrix minerals for 14 thin sections are given in Table 5. Although quartz and feldspar are universally present in the matrix, some of the point counts presented in Table 4, for example sample H-73-84(G), illustrate that in some instances, quartz and feldspar form a minor constituent of the matrix. The large amounts of epidote in some samples, 12.2 percent in H-73-84, presumably were derived from the breakdown of feldspathic minerals, although a detrital origin is also possible.

As discussed below in the section on "Matrix Modification and Petrography of the Sandstones", much of the matrix in many of the samples studied appear to have been derived from the breakdown of volcanic rock fragments. In the lithic subarkosic and arkosic wackes the author considers that the composition of the principal volcanic rock fragments was felsic to intermediate.

Graded Wacke-Mudstone

These rocks exhibit graded bedding. The basal parts have a wacke composition and the upper parts a mudstone composition. These upper and lower parts

TABLE 5 MATRIX MINERALS IN LITHIC SUBARKOSIC AND LITHIC SUBARKOSE WACKE, HEWITT LAKE AREA.

Sample Number	W-73-34	H-73-21	H-73-84	W-73-53	W-73-34	W-73-18	R-72-213
Mineralogy							
Biotite	1	—	1	1	1	—	1
Chlorite	1	1	1	—	—	—	—
Muscovite-Sericite	1	1	1	1	1	—	1
Actinolite	—	—	1	—	—	1	—
Epidote	1	1	1	1	—	1	1
Carbonate	—	—	—	—	1	—	—

Sample Number	W-72-90	W-73-21	H-73-55	H-73-33	W-72-48	W-72-101	R-72-225
Mineralogy							
Biotite	1	1	1	1	1	1	1
Chlorite	1	—	1	—	—	—	1
Muscovite-Sericite	1	—	1	1	1	1	1
Actinolite	—	—	1	—	—	1	—
Epidote	—	1	—	—	—	—	1
Carbonate	—	—	1	1	1	—	1

Abbreviations:
1 - Mineral present
— - Not detected

are mineralogically and texturally similar to other wackes and mudstones described in preceding and following parts of the text.

Feldspathic Lithwacke

This rock type, although developed only on a local scale, occurs in several localities within the map-area. Some of these localities are as follows: the southern shore of South Bay, east of the small lake south of Wokokotai Lake, and about 3 km south of the western end of Makataiamik Lake. On weathered outcrop surfaces, the rocks are dark green to green-grey. In some localities in the map-area, these rocks were judged at the time of mapping to be pyroclastic in origin. The rock type occurs in thin to thick beds that have no apparent internal structures.

Lithic clasts, generally mafic to intermediate in composition, although some are of felsic composition, can usually be recognized in hand specimen. Quartz and feldspar (plagioclase) are present in all occurrences, but cannot be recognized in hand specimen in some localities because of the small amounts present.

In thin section, the rocks are revealed to be texturally similar to the wacke just described in having a framework and matrix. The matrix grain size ranges from 0.02 to 0.05 mm, the framework clasts range from 0.3 to 1 mm, and do not touch. As in the other wackes described above, the most prominent matrix components are quartz and feldspar. The mineral frequency analysis of sample W-73-13(H) given in Table 4 illustrates that the framework quartz and feldspar constitute only a small part of the rock. Apparently, a considerable clast to matrix transformation has occurred in all the six thin sections examined by the author. Mineralogically, the matrix consists of quartz, feldspar, biotite, opaque minerals, amphibole, muscovite, carbonate, epidote, and sphene. Probably the original lithic compositions included felsic, intermediate, and mafic metavolcanics, In the samples from the southern shore of South Bay, some clasts are very similar in texture and composition to rocks of the Bijou Point Complex (Wood 1977).

Matrix Modification and Petrography of the Sandstones

In the part of this report on "Boulder to Granule Orthoconglomerate with a Wacke Mudstone Matrix" it was noted that rock fragments, particularly fine-grained mafic rock fragments have occasionally merged into the conglomerate matrix. This also has occurred occasionally in the sandstones. It causes problems in attempting to reconstruct the original nature of a sandstone. It should be pointed out that the sandstone classification used in this report assumes that the components of the matrix cannot be identified. This is not so in most of the sandstones from the Hewitt Lake area. In order to more clearly illustrate the importance of matrix in classifying a sandstone, and to graphically show the petrographic features of some of the sandstones, two diagrams, combined as Figure 8, have been constructed.

The ten samples used in Figure 8 were chosen to represent a spectrum between rocks which had undergone no apparent sand to matrix transformation (for example, rock B) to those which indubitably had undergone sand to matrix transformation (for example, rock E). The rocks were modally analyzed on a regular polarizing microscope with only those fragments of unequivocal sand size being counted as framework; all others were counted as matrix, and the mineralogy was noted. The thin sections were then inspected on a polarizing microfisch reader and a careful check made of "matrix" areas. In several instances, for example, rocks A,E, and H, it was apparent that "matrix" areas were composed of sand-sized fragments whose outlines had been almost completely obliterated. Using the point counts, some of which are given in Table 4, the rocks were then assigned a name based on the mineralogy and an assessment of the original texture. For this reason the names in Table 4 may seem to diverge from the point counts.

Figure 8 illustrates grain frequency analyses of ten metasediments plotted in two ways similar to Figure 6. The subscript "T" indicates the plot of the total of an analysis without reference to grain-size, the subscript "F" indicates the plot of the sand-sized (framework) constituents recalculated to 100 percent. Diagrams of this type have certain inherent characteristics such as:

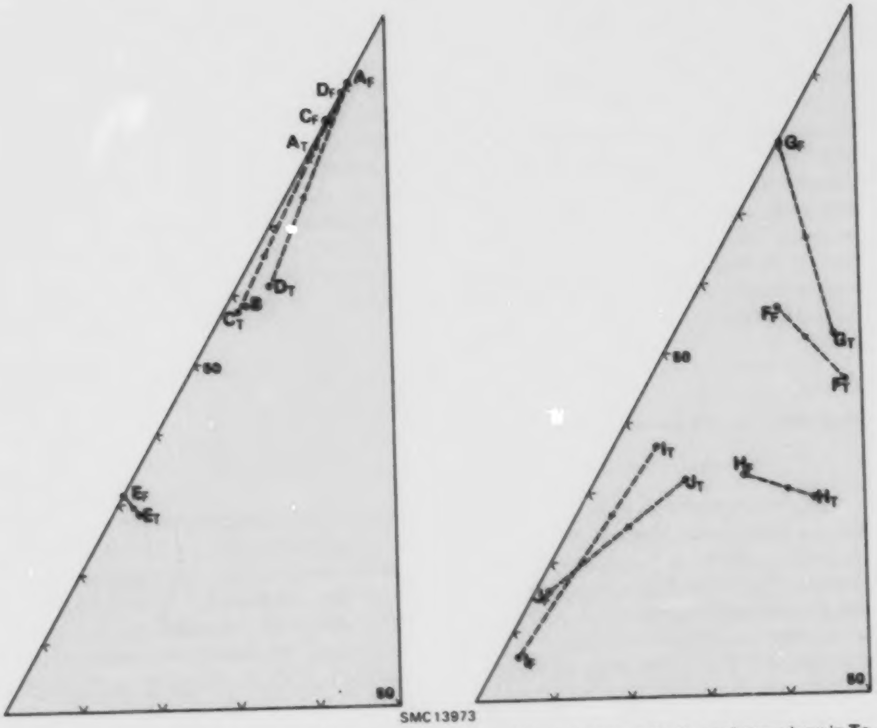

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Figure 8–Diagrams showing compositional analyses of sandstone. Letters refer to analyses given in Table 4 (see section on "Matrix Modification and Petrography of Sandstone" in text).

a) An arenite with no matrix will have only one position on the diagram, rock "B" is an example.
b) If the mineralogy of the matrix is the same as that of the framework, and the proportions in both are identical, the two plots of a rock will be superimposed.
c) The greater the contrast in proportion and mineralogy of the framework and matrix the longer the tie lines will be between the positions of the two plots.

Several relationships can be illustrated from and conclusions can be made from the diagrams, these are:

1) Almost all of the samples, obvious exceptions are F and H, apparently have either quartz and/or feldspar as the important framework constituents.
2) Samples G, F, and H have long tie lines that extend towards the labile minerals and rock fragments apex, indicating a high percentage of immature matrix in these samples. In each of these samples the matrix is composed of mafic minerals.

3) Samples A, D, I, and J, have long tie lines that are parallel or subparallel to the quartz-feldspar side of the triangle. These samples have only very small amounts of mafic constituents, which means that the matrix in these four samples is quartzofeldspathic. Rock fragments in the framework of the four samples were not readily identifiable by the regular polarizing microscope but were recognizable using a polarizing microfisch reader.

4) Samples F and H have obvious framework rock fragments and contain the greatest amount of labile minerals and rock fragments.

A comparison of Figure 8 with Figure 6 indicates that sandstone is more quartzofeldspathic than the conglomerate matrix. In the conglomeratic rocks, the greatest problems were experienced with the disappearance of mafic rock fragments. Items 2 and 4 indicate that in the sandstones, rock fragments can generally be recognized in the members with more mafic matrix (compare point counts in Table 4). The problem with sandstone in the Hewitt Lake area is caused by the difficulty in distinguishing felsic volcanic rock clasts from the matrix. In some rock samples, the felsic metavolcanic fragments are easily visible; in other sample suites there is a complete progression between samples with lithic clasts and samples containing no easily recognizable rock fragments, but having a matrix identical mineralogically and texturally, to clasts of felsic metavolcanics. Such a matrix could be the result either of incorporation of lithic sand sized clasts by diagenetic or metamorphic processes in the matrix, or of normal sedimentary processes. Thin section textures which suggest that felsic metavolcanic clasts have in some cases been incorporated into the matrix indicate that this mode of matrix formation is the more important in rocks within the map-area.

It is therefore concluded that:

a) Sand grains have been incorporated in the matrix of some of the sandstones in the map-area.

b) Some of the apparent "wackes" in the map-area originated as arenites and may have had very little detrital matrix.

c) Although the wackes are texturally immature sedimentary rocks, care must be exercised in interpreting the mode and environment of deposition of wacke beds.

Mudstones

Mudstone in the map-area has been partly subdivided into siltstone and shale. Within the content of this report a "shale", is an indurated, fissile, rock composed of clay-sized grains. Shales form only a minor part of the mudstone sequence in the map-area. Outcrops marked on the map as "mudstone" consist of shale and siltstone.

In outcrop, the mudstones are indurated, and do not necessarily break along bedding planes. Where the metamorphic grade is high, such as around the Margot Lake granitic body, the rock breaks parallel to the schistosity,and where dynamic metamorphism has been intense, the rock will break parallel to the induced phyllitic foliation.

The colour of the mudstones on weathered surfaces varies from place to place but in any one locality is usually constant. Their colour is generally grey to black due to the inherent fine-grained nature of the rocks. In some localities, for example just to the east of Hewitt Lake and in the neighbourhood of Margot Lake, mudstone weathers to a buff colour similar to that of the weathered surfaces of the felsic to intermediate metavolcanics.

Most of the mudstone within the map-area is medium to thinly bedded. East of Hewitt Lake, very finely bedded siltstone is exposed. Although these outcrops are not large, generally less than 60 m across the bedding strike direction, many thousands of beds are exposed on any one outcrop. These very finely bedded siltstones are always siliceous.

Internal structures are scarce in the fine-grained rocks. One of the few localities where graded bedding was observed in mudstone, is on the eastern shore of South Bay. The beds are in the order of 2.5 cm in thickness, are siliceous, and have light buff-coloured bottoms and dark tops representing siltstone and shale respectively. On the northern shore of Hewitt Lake near its western end, reverse graded bedding is visible in argillaceous rocks in which metamorphism has caused preferential development of andalusite in the originally finer grained parts of beds.

Siltstone (Medium to Thinly Bedded, Thinly to Very Thinly Bedded)

The distinction between the medium- to thinly-bedded and the thinly- to very thinly-bedded siltstone is based on field observation. Thin section examination reveals that all the siltstones are similar, they are composed primarily of quartz and feldspar (up to 75 percent of the total rock), the quartz and feldspar grains range from 0.01 mm to 0.06 mm in size, and have a unimodal size distribution. Mineralogical variations that occur are as follows: biotite present in six out of eight thin sections; muscovite, present in six of eight; chlorite in minor amounts, three out of eight thin sections; epidote three out of eight thin sections; actinolitic amphibole, two out of eight thin sections; and opaque minerals are present in all thin sections. In three thin sections, muscovite forms almost 20 percent of the rock and in two of these three thin sections biotite and other mafic minerals are absent. The buff-coloured weathered surface of many of these siltstones is probably a consequence of the felsic nature of the rock.

Shale, Mudstone, and Graded Siltstone-Shale

The shale beds in the mudstones and graded mudstones differ from the siltstones only in having a greater amount of micaceous material of fine grain size. With the exception of the black-shale described below, all of the shales in the map-area contain silt-sized quartz and feldspar, and there appears to be a complete transition between siltstone and shale. The graded units do not show any distinctive decrease in size of the quartzofeldspathic grains towards the stratigraphic top of a bed, but rather a decrease in the numbers of such grains.

Black Shale

This rock type, distinctive in the field because of its black colouration and very fine grain size, has been found in the map-area only in association with quartz magnetite iron formation, for example along the south shore of the east arm of Hewitt Lake. A similar association was found in the North Spirit Lake area (Wood 1977). A black shale unit lies stratigraphically on top of the iron formation unit.

In thin section, the rock is black and opaque, only minor muscovite and unrecrystallized chert are identifiable. Glass breakage during thin sectioning, suggests clay minerals may be present.

High-Grade Metasediments

The occurrences of higher grade metasediments in the map-area have been outlined in the introduction to the section on sandstones. All the highly metamorphosed sedimentary rocks are described together because the textures of a high grade schist are uniform regardless of whether the rock originated as a wacke or mudstone, and because the resultant rock types are generally mineralogically similar. The assignment of a particular rock to the sandstone or mudstone class in the map-legend (Map 2408, back pocket) is based on field mapping. Despite the high metamorphic grade of many of the rocks in the vicinity of the Margot Lake granitic body, bedding is generally preserved (Photo 13). Internal structures such as reverse graded bedding in which the pelitic part of a graded bed has become coarse grained due to the growth of porphyroblasts of andalusite and cordierite are also preserved. On the basis of bedding thickness, the presence or absence of graded bedding, and the amount of micaceous minerals in a rock, the original wacke or mudstone classification can generally be applied with confidence to these rocks. These rocks with a large volume of micaceous minerals were considered to have been originally mudstones. Within the map-area, a complete spectrum of variation exists from rocks that are barely metamorphosed to those that underwent partial melting. The following rock descriptions are intended to illustrate examples of the textures and mineral assemblages of metasediments at levels of metamorphism greater than that of the rocks described thus far in the section on metasediments.

Biotite-Andalusite-Muscovite Schist

This rock type outcrops 1.5 km east of the eastern end of Hewitt Lake. The rock is medium bedded, light coloured, and siliceous, with a well-defined foliation and a later crenulation defined by micaceous minerals.

In thin section, the foliation and crenulation are distinct. Muscovite is the most important micaceous mineral (about 20 percent) with minor (about 2 percent) biotite and chlorite; quartz (extensively polygonized) constitutes about 75 percent of the rock, and andalusite about 2 percent, opaque minerals constitute

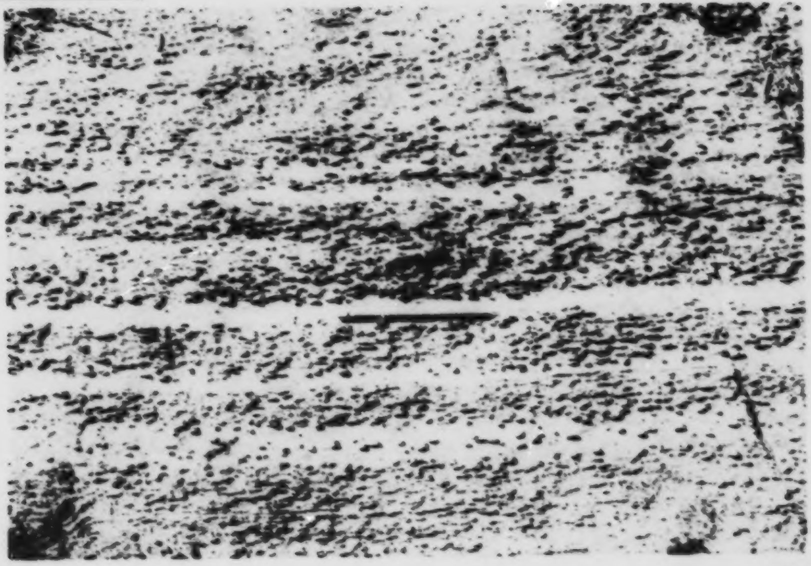

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Photo 13–Andalusite schist. Bedding is well preserved despite metamorphism. The pencil is 28 cm long.

the remainder. The quartz grains range in size from about 0.5 mm down to 0.03 mm. The andalusite crystals, which are altered to sericite and chlorite, appear to post-date the muscovite. The rock can be classified in the quartz-andalusite-plagioclase-chlorite subfacies of the greenschist facies of the Abukuma-type facies series (Winkler 1967).

Garnet-Andalusite-Muscovite-Biotite Schist

The rocks adjacent to the Margot Lake granitic body and the dioritic body north of Hewitt Lake are transitional between the greenschist facies and cordierite amphibolite facies of the Abukuma-type facies series (Winkler 1967). Garnet and to a lesser extent andalusite (Photo 13) and cordierite are readily recognizable on outcrop.

The following description is of a thin section of a sample taken from an outcrop west of Hewitt Lake and south of Hewitt Creek and adjacent to a dioritic intrusion. All the quartz and feldspar grains are sand sized and show no readily apparent multimodality in grain size distribution. A schistosity is defined by the parallel orientation of micaceous minerals, which also parallels the direction of elongation of quartz and feldspar grains. Quartz grains show incipient polygonization which can be related to the cataclastic deformation in this part of the map-area. Minerals in the rock include quartz, plagioclase, biotite (brown), muscovite, andalusite, garnet, and minor opaque minerals. All the minerals in the rocks with the exception of andalusite and garnet have been influenced by deformation, andalusite and garnet have grown after the deformational event which affected the rest of the rock. Garnet is less than a millimetre in diameter and is euhedral, andalusite is randomly oriented, contains quartz inclusions, and is up to 1 cm long.

This rock does not fit directly into any of the classical subfacies of any facies series (see Winkler 1967; Turner and Verhoogen 1960). F.J. Turner and J. Verhoogen (1960, p.514) indicate that andalusite, muscovite, and biotite may coexist and that almandine may occur in some cordierite-bearing assemblages. However, cordierite was not identified in the rock, suggesting that the assemblage identified may be the result of either the original composition of the rock or unique local metamorphic conditions. Relative to the Abukuma-type facies series to which other rocks in the map-area are referred, the rock can probably be assigned to the lower part of the cordierite-amphibolite facies.

Cordierite-Biotite Schist

This rock is higher in grade than the rock previously described. The sample to be described, comes from north of the central section of the western half of Hewitt Lake where a sequence of metasediments occurs close to a dioritic intrusion. Similar rock types occur close to the Margot Lake granitic body, for example east of Little Hewitt Lake. Although the rock contains cordierite, the cordierite may not be obvious in hand specimen or outcrop.

Thin section examination reveals that the foliation of the rock is defined by biotite. Grain size varies from about 0.03 to 3 mm. The larger grains are composite quartz crystals. Bimodality in grain size of the quartz grains is not apparent. Minerals present are: quartz, plagioclase, biotite, cordierite, with accessory opaque minerals and zircon. The maximum dimensions of the cordierite crystals are 2 mm long by 1.5 mm wide, the crystals are twinned and contain quartz inclusions. This rock type may belong to either the andalusite-cordierite-muscovite subfacies of the cordierite-amphibolite facies, or the quartz-andalusite-plagioclase-chlorite subfacies of the greenschist facies of the Abukuma-type facies series (Winkler 1967).

Cordierite-Sillimanite-Biotite Schist, Sillimanite-Garnet-Staurolite-Muscovite Schist

The metasediments south of Margot Lake have been injected in *lit-par-lit* style by granitic material and exhibit an anatectic quartzofeldspathic neosome indicative of partial melting. Throughout this locality, sillimanite is present in the metasediments (Photo 14), some crystals reaching 6 cm in length. In one isolated outcrop, garnet, staurolite, and sillimanite were observed, this to the author's knowledge is the only occurrence of staurolite in the map-area. On outcrop, the sillimanite, not always the cordierite, is readily recognizable.

Thin section examination reveals that the quartzofeldspathic minerals are

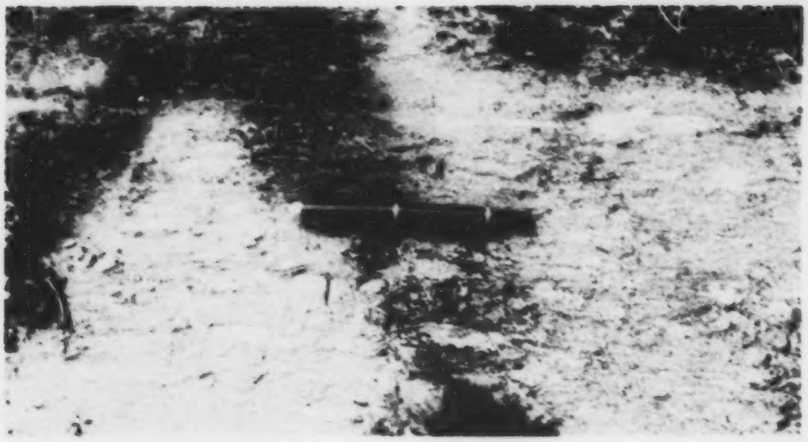

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Photo 14–Sillimanite schist. The sillimanite crystals are generally smaller than in the illustration (the pen is 13 cm long).

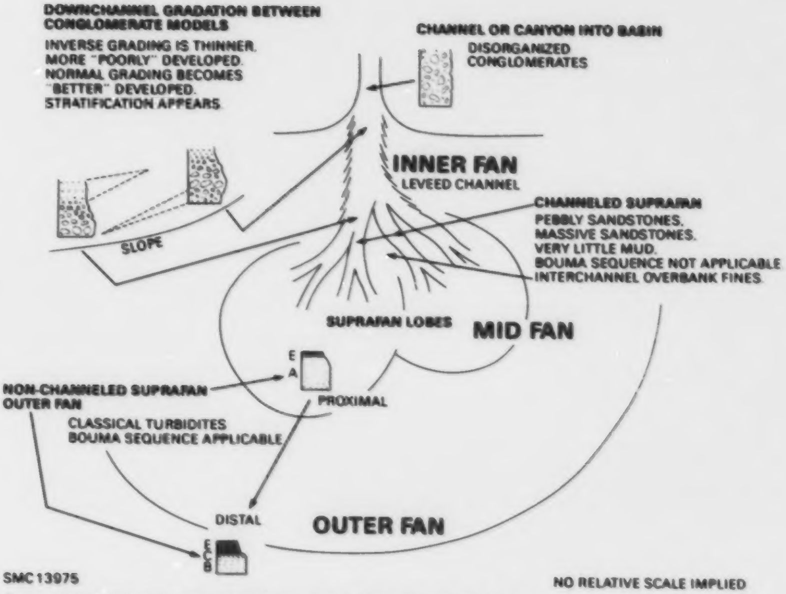
equigranular and sand-sized. Minerals present are quartz, plagioclase, microcline, biotite, sillimanite, and cordierite, with accessory tourmaline. The cordierite crystals are less than 2 mm in diameter, but the sillimanite crystals occur in knots that are as large as 1 cm in length and 5 mm in width. The rock can be classified in the sillimanite-cordierite orthoclase-almandine subfacies of the cordierite-amphibolite facies of the Abukuma-type facies series (Winkler 1967).

Depositional Environments of Clastic Metasediments

The interpretation of depositional environments in an Archean terrain such as in the map-area is hampered by the steep dip of beds, the two-dimensional nature of the glaciated outcrops, and the uneven distribution of sedimentological data. Nevertheless, a general statement on the genesis of these rocks can be made.

As outlined in the section "Sedimentary Structures," sandstone south of Makataiamik Lake shows the characteristics compatable with deposition by turbidity currents. Since sandstone and conglomerate are intimately associated with each other in the same region (see Figure 9) conglomerate probably originated in a similar environment.

R.G. Walker (1975) developed three models for re-sedimented conglomerate of the turbidite association. These are: the disorganized bed model, boulder to granule orthoconglomerate with a wacke-mudstone matrix and the boulder


DOWNCHANNEL GRADATION BETWEEN CONGLOMERATE MODELS
INVERSE GRADING IS THINNER.
MORE "POORLY" DEVELOPED.
NORMAL GRADING BECOMES "BETTER" DEVELOPED.
STRATIFICATION APPEARS.
CHANNEL OR CANYON INTO BASIN
DISORGANIZED CONGLOMERATES
SLOPE
INNER FAN
LEVEED CHANNEL
CHANNELED SUPRAFAN
PEBBLY SANDSTONES.
MASSIVE SANDSTONES.
VERY LITTLE MUD.
BOUMA SEQUENCE NOT APPLICABLE
INTERCHANNEL OVERBANK FINES
SUPRAFAN LOBES
MID FAN
E
A
NON-CHANNELED SUPRAFAN OUTER FAN
PROXIMAL
CLASSICAL TURBIDITES
BOUMA SEQUENCE APPLICABLE
DISTAL
OUTER FAN
E
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NO RELATIVE SCALE IMPLIED

Figure 9–Model of a submarine fan system (after Walker 1975).

to cobble paraconglomerate with an argillaceous matrix are the suggested equivalents within the map-area; the graded-stratified model, cobble to granule orthoconglomerate and boulder to granule paraconglomerate are the suggested equivalents within the map-area; and the inverse to normally graded model which has its equivalents in several of the conglomerate types within the map-area. The submarine fan model developed by Walker (1975) is reproduced in Figure 9. A close comparison exists between the characteristics of the rocks in the field area and the submarine fan model. The lowermost conglomerate along the northeastern edge of the metavolcanics within the map-area is comparable to canyon deposits consisting of disorganized conglomerate. The inverse to normally graded conglomerate; and the graded stratified conglomeratic rocks of the inner to mid fan (see Figure 9) are represented by the sequence southwest of Makataiamik Lake where there are abundant inversely graded, normally graded, and stratified rocks with pebbly sandstone, massive sandstone, and many channels. The outer fan (see Figure 10) corresponds to the uppermost part of the sequence southwest of Makataiamik Lake, and to the remainder of the metasediments within the map-area. The only significant development of conglomerate is in the northeast part of the map-area. Metasediments in the remainder of the map-area are either sandstone or mudstone with only local development of conglomerate, and are typical turbidite deposits. Therefore, the author considers that the sedimentary rocks within the map-area are submarine fan deposits.

CHEMICAL METASEDIMENTS

There are three types of chemical sedimentary rocks, they are: para-amphibolite; siliceous and ferruginous metasediments; and calcareous metasediments. The siliceous and ferruginous class includes several rock types such as chert and iron-formation, the carbonate class includes only marble, the para-amphibolite class includes only para-amphibolite.

There is a spatial association between the three classes of rocks within the map-area. However, isolated occurrences of any one rock type can and do occur, whether or not this is simply a function of outcrop density and distribution is not known.

Para-Amphibolite

Para-amphibolite is not a common rock type within the map-area, it usually occurs in association with siliceous chemical metasediments except north of the east end of Hewitt Lake. The rocks are green both in outcrop and fresh surface, and can be recognized in the field as sedimentary rocks because of their distinct thin bedding. In places, beds only millimetres thick were encountered, such very fine beds are distinguished on Map 2408 (back pocket).

Thin section examination of a grab sample of para-amphibolite from near Nipa Lake reveals that the mineralogy consists of an actinolitic amphibole (very pale green), quartz (recrystallized chert, grain size 0.02 to 0.03 mm), and magnetite. In this sample, "beds" were defined by layers of meta-chert and amphibole; the amphibole layers in particular are magnetite rich, containing up to 15 percent magnetite. The grain size of the amphibole is about 0.3 mm.

Siliceous and Ferruginous Metasediments

This group of rocks includes chert; chert with pyrite and pyrrhotite; chert-pyrrhotite iron formation; chert-magnetite iron formation; ferruginous chert; and chert with magnetite, pyrite, and pyrrhotite.

These rock types will be discussed together because they have lithological similarities and are genetically related. The unifying feature of these rock types is that they all contain chert. Some concept of the variation in minerals associated with chert can be observed in the locality of the eastern arms of Hewitt Lake and Wokokotai Lake, where along strike from northeast to southwest, a siliceous metasedimentary unit changes composition from a chert, to a chert with magnetite, pyrite, and pyrrhotite, to ferruginous chert. Because of the low outcrop density in this locality, the author was unable to determine whether the gradation from rock type to rock type was due strictly to lateral facies changes or the gradation was in part a function of stratigraphic position within the siliceous unit. Exploration work has been carried out on the sulphide-rich parts of this unit (see section on "Economic Geology").

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Photo 15–Chert-magnetite iron formation. The light layers are recrystallized chert, and the dark layers are magnetite. There is considerable variation in bedding thickness. This outcrop is complexly deformed. The hammer handle is about 30 cm long.

Photo 15, a photograph of a banded iron formation unit about 2.5 km southwest of Makataiamik Lake, illustrates the general appearance of the cherty units. The banded appearance is obvious and the light-coloured bands are composed mainly of recrystallized chert and the dark-coloured units are composed essentially of magnetite. The sulphide-rich cherty rocks contain sulphide minerals instead of magnetite. In some cherty rocks, the individual bands are not radically different in composition; in the chert *sensu stricto* individual bands are all composed mainly of chert and exhibit only slight colour differences from bed to bed presumably due to minor amounts of impurities, or perhaps other minor original differences. The bed thicknesses of the iron formation illustrated in Photo 15 are typical of all the cherty rocks regardless of composition. The amount of deformation illustrated is not typical of the cherty units in all parts of the map-area.

Chert occurs with other chemical metasediments such as lean iron formation, for example in the locality of Hewitt Lake and Wokokotai Lake, and in association with clastic sedimentary rocks, for example east of the eastern arm of Hewitt Lake. In the first association, chert is medium-to-dark grey to almost black on fresh and weathered surfaces. Thin section examination reveals that this type of chert rock is fine grained, and has a grain size ranging between 0.01 to 0.04 mm. Quartz is the dominant mineral with minor opaque minerals and silicate minerals such as muscovite, amphibole, tourmaline, and sphene.

The chert which occurs with the clastic sedimentary rocks is very finely bedded, but does not have the rather translucent and grey-black colour of the chert associated with iron formation. The chert weathers buff; the fresh surface is dark grey to black. The rock type is exceedingly tough. The buff weathering colour of field exposures indicates that the rock probably originated partly as a chemical sediment, and partly as a clastic sediment.

The chert sulphide and chert sulphide-oxide rocks are very similar to one another. The sulphide minerals occur interlayered with chert and where an oxide mineral is present, it occurs in the sulphide layers. In the exposures examined by the field party, it forms only a minor proportion of the sulphide layers.

The sulphide minerals are primarily pyrite and pyrrhotite but arsenopyrite, chalcopyrite, and sphalerite have been reported (see sections on Chimo Occurrence (1)[1] and (11), and Interlac Occurrence (6)). The association of sulphide minerals and oxide phases together is not unreasonable. Experimental data (Krauskopf 1967) has shown that magnetite and pyrite share a common phase boundary under certain conditions of Eh-pH and sulphur concentration. Assessment files for Chimo Gold Mines Limited in the Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake, indicate that the sulphide minerals form up to 75 percent of the layers in which they occur, and that the remainder of a sulphide layer is composed of chert or chert and carbonate. A thin section of a sample containing less than 10 percent total sulphide and oxide minerals, examined by the author indicates that the rock is composed primarily of a polygonal mosaic of quartz having a grain size 0.03 to 0.05 mm. The rock is layered, some layers consist almost entirely of quartz with traces of amphibole and opaque minerals. The other layers consist of quartz (about 85 percent); opaque minerals (10 percent); a colourless amphibole possibly grunerite, chlorite, and stilpnomelane form the remainder of the rock.

The ferruginous chert is similar to the cherty rocks already described, but has more magnetite, the iron formation has a large amount (greater than 15 percent) of magnetite. Although a large tonnage deposit of iron formation has been outlined in the North Spirit Lake area (*see* Wood 1977; and the Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake), no similar deposit is known within the map-area. Thin section examination reveals that the rock is texturally similar to the other cherty rocks, the oxide-rich layers are composed of magnetite accompanied by quartz (recrystallized chert), amphibole (grunerite, cummingtonite), chlorite, and carbonate.

Carbonate Rocks

Marble

A calcareous marble is the only carbonate rock type in the map-area. Thin section examination indicates that the rock is composed almost entirely (98 percent) of coarse-grained carbonate which, when analyzed by the Geoscience

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[1] Number in parentheses refers to property number on Map 2408, back pocket.

Laboratories, Ontario Geological Survey was revealed to be calcite. Accessory minerals are quartz and opaque minerals. The rock is light grey on weathered and fresh surfaces. The best development of marble is in the central part of the map-area near Hewitt Lake and Wokokotai Lake. In the section on mafic metavolcanics, a carbonatized mafic metavolcanic unit was described (see section on "Mafic Metavolcanics"). In the eastern half of the map-area near Hewitt Lake where the carbonate constitutes a mappable unit some 120 m thick, there is a spatial association of carbonate and carbonatized mafic metavolcanics. The author considers that the carbonate and carbonatized mafic metavolcanics in the eastern half of the map-area are the equivalent, along strike,to similar rocks in the western half of the map-area between Little Hewitt and Hewitt Lakes.

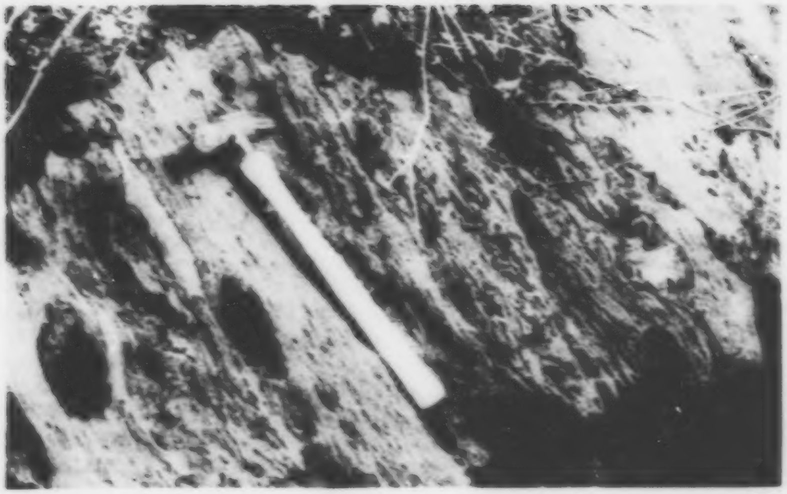
Inter-Relationships of Chemical Metasediments

There is a spatial relationship between the three classes of chemical metasediments, and there is probably a complete variation within the siliceous class. The occurrence of amphibole in the siliceous metasediments and chert in the para-amphibolite suggests that these two classes overlap to some extent. Some carbonate was found in the siliceous metasediments and recrystallized chert in the carbonate metasediments, indicating some overlap. Diamond-drill hole data from Chimo Gold Mines Limited (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake) suggest that the rock sequence underlying part of their former claim group on the northern shore of the eastern part of Hewitt Lake (see section on "Chimo Occurrence (1)") may consist of interbedded carbonate and chert. One outcrop (Photo 16) of impure sheared carbonate on the former property of Chimo Gold Mines Limited contains pods of quartz about 7.5 to 10 cm in diameter. The author's interpretation of this is that the rock originally consisted of chert beds in carbonate and that deformation and metamorphism has effectively boudinaged the chert, recrystallized it to quartz, and rounded the boudins into an elliptical shape.

The author concludes that an overall genetic relationship exists between the different classes of chemical metasediment. Probably there are more outcrops of siliceous metasediments than other chemical metasediments because of the chemical stability and resistance to erosion of the siliceous rocks. More carbonate and para-amphibolite may underly the map-area than the outcrop pattern suggests (Map 2408, back pocket).

Stratigraphy of Metavolcanics and Metasediments

Stratigraphic relationships can be interpreted only in the northeastern part of the North Spirit Lake Belt because of structural deformation elsewhere. To help in the elucidation of the stratigraphy in the map-area, vertical sections have been reconstructed from four localities (see Figure 13) and are illustrated in Figure 10. Generalized vertical sections (a) and (b) are from the Hewitt Lake area, Map 2408, back pocket; and sections (c) and (d) are from Map 2362, North



ODS 10 169

Photo 16–Sheared carbonate-chert rock. Chert beds have been boudinaged in a plane parallel to the visible foliation. Some boudins have been eroded from the rock, others, for example, near the right edge of the photo, are in place. The hammer handle is 33 cm long.

Spirit Lake (Wood 1977). The generalized vertical sections in Figure 10 are alphabetically arranged south to north.

The reference line in Figure 9 is the base of the lowermost conglomerate unit. In Figure 10 section (a), the mafic metavolcanics, lowermost conglomerate, and underlying ultramafic rocks are extrapolated from the geology north of the west end of Makataiamik Lake. The genesis of, and the original thickness of the ultramafic rocks at the base of sections (a) and (c), (Figure 10), are not known. The base of section (d), (Figure 10) is the North Spirit Lake Fault so the thickness of the conglomerate unit there is not known.

The vertical sections in Figure 10 reveal the following:

1) The stratigraphic sequence in all four sections in ascending stratigraphic order is conglomerate, sandstone, shale and/or chemical sedimentary rocks (marble or cherty iron formation), and felsic to intermediate rocks;

2) Mafic metavolcanics are present only in section (a), and there are more felsic to intermediate flow rocks in section (a) than in any other section;

3) The thickness of the lower conglomerate unit varies in vertical sections (a), (b), and (d); the unit is absent in section (c);

4) The thickness of units in section (a) exceeds that of similar units in other sections, even if allowance is made for faulting in section (d). Also, the thickness of the sequence in section (c) is less than any in of the othe vertical sections;

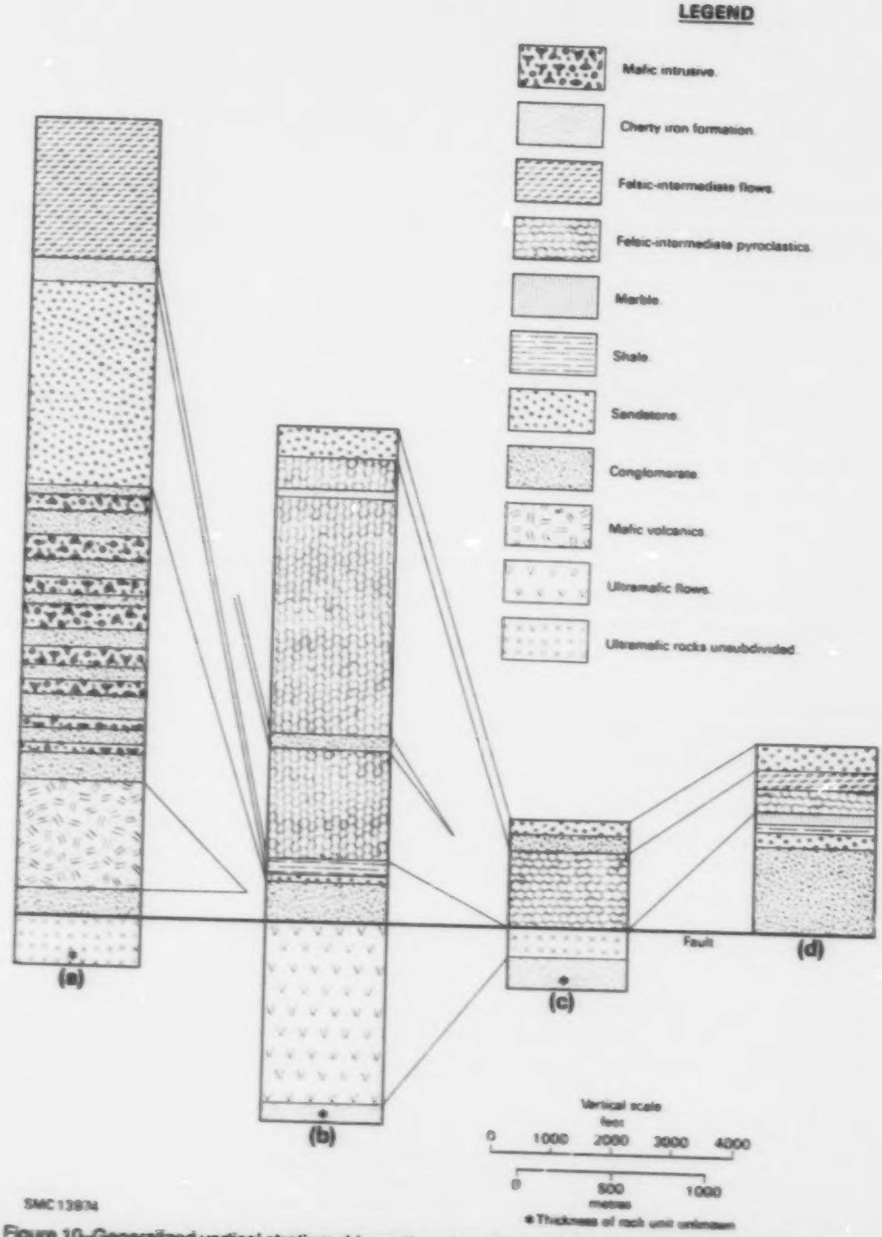

LEGEND
Mafic intrusive.
Cherty iron formation.
Felsic-intermediate flows.
Felsic-intermediate pyroclastics.
Marble.
Shale.
Sandstone.
Conglomerate.
Mafic volcanics.
Ultramafic flows.
Ultramafic rocks unsubdivided.
(a)
(b)
(c)
(d)
Fault
Vertical scale
feet
0 1000 2000 3000 4000
0 500 1000
metres
* Thickness of rock unit unknown
SMC 13874

Figure 10–Generalized vertical stratigraphic sections from four localities in the North Spirit-Hewitt Lakes Area; section (a) is a composite of two sections (see Figure 13). Please refer to section on "Stratigraphy of Metavolcanics and Metasediments."

5) The stratigraphic position of the base of the felsic to intermediate metavolcanic unit may represent a time plane. When that volcanic event began there was a considerable thickness of sediments in location (a), a thin sequence in section (b), none in section (c), and at least 600 m in section (d);

6) The thickness of ultramafic rocks in section (b) is much greater than in section (c);

7) Deformation undergone by the rocks below the conglomerate in section (b) is minor compared to that undergone by the rocks below the felsic to intermediate pyroclastics in section (c). There are on either side of section (c), conglomeratic rocks consisting of ultramafic detritus (see section on "Boulder to Granule Orthoconglomerate, with Feldspathic Lithwacke Matrix").

8) The sandstone in vertical section (a) is characterized by chromium-rich mica.

One conclusion that can be drawn from the preceding point is that the ultramafic rocks were being actively eroded and supplying detritus during the formation of the conglomerates and sandstones in section (a), and that the interface between conglomerates, the felsic to intermediate pyroclastic rocks, and the underlying ultramafic rocks is an erosional unconformity.

Conglomerate lies above ultramafic rocks exposed from Wapisipi Lake to Makataiamik Lake. This suggests that in this area the unconformity is more of a disconformity unless the original thickness of the ultramafic rocks was great. Northwest of Wapisipi Lake (beyond the map-area), the unconformity has considerable angularity. The probable events that took place in the locality represented by section (c) are: active deformation; uplift; and at some point, erosion. While these events took place, the localities represented by section (a),(b), and (d) underwent gentle subsidence and were the sites of clastic sedimentation.

Near Makataiamik Lake, the grain size of the metasediments decreases in a southerly direction, and is reflected in the thinning of the conglomerate rock sequence to the south suggesting that the paleocurrent direction had a strong northerly component.

Detailed work could further elucidate stratigraphic and paleogeographic problems.

Metamorphosed Ultramafic Intrusive Rocks

The petrography of all the ultramafic rock types within the map-area is discussed in the section on ultramafic metavolcanics. A discussion of the problem of the genesis of ultramafic rocks is given in the section on ultramafic metavolcanics.

Metamorphosed Mafic Intrusive Rocks

The most important occurrence of metamorphosed mafic intrusive rocks is south of Makataiamik Lake. Mafic intrusive rocks have also been mapped south of Little Hewitt Lake, but diagnostic criteria indicating whether these rocks are coarse-grained mafic metavolcanics, gabbroic intrusive rocks, or rocks related to the ultramafic rocks in that locality were not discovered. No thin sections of rocks from this locality were available at the time of writing. On outcrop surfaces the rocks are dark green to black, medium grained, slightly foliated, and composed of amphibole and plagioclase. Some strongly foliated outcrops were noted, and these probably represent rock outcrops sheared by faults of the fault-system in the southwestern part of the North Spirit Lake Belt.

The mafic intrusive rocks which occur immediately to the south of Makataiamik Lake are dark green to black, and medium to fine grained. Metamorphosed mafic rocks of intrusive origin occur in the vicinity of the McDonald Occurrence (10), and were recognized in the adjacent area to the south during the 1975 field season. The rock-type of this body is similar to that comprising the intrusions immediately to the south of Makataiamik Lake, suggesting that the rocks in the two localities were comagmatic.

Most of the intrusions immediately south of Makataiamik Lake are sill-like and concordant to sub-concordant with the bedding in the metasediments. In one locality about 1.5 km south of the western end of Makataiamik Lake, a mafic intrusion cuts the bedding of the metasediments at a high angle. The intrusions pinch out in a northwesterly direction, and the author has interpreted the sills which interfinger with the sedimentary rocks as thickening and merging with one another towards the southeast, thus coalescing into one large body most of which has been removed by tectonic processes.

A poorly developed foliation can generally be observed on outcrop surfaces. No indication of a foliation is readily visible on a thin section scale, the rock having a massive appearance. The minerals visible in thin section are: hornblende, pleochroic from a light green-brown to a light blue-green, and frequently poikloblastic in texture (50 percent); plagioclase, composition in the range An_{35} to An_{55} (43 percent); quartz, interstitial, and in traces as a micrographic intergrowth 5 percent; magnetite (2 percent); biotite, apatite, and chlorite, comprise the remainder of the rock. A thin section of a sample from an outcrop some 1200 m south of the western end of Makataiamik Lake showed a relict diabasic texture between euhedral to subhedral plagioclase and interstitial hornblende. The original mineralogy and composition of these mafic intrusive rocks probably approximated those of a gabbro.

Felsic and Intermediate Intrusive Rocks

METAMORPHOSED GRANITIC ROCKS

The metamorphosed granitic rocks occur within the North Spirit Lake Belt in contrast to the batholithic granitic rocks. The rocks occur in two forms, as relatively thin sill-like bodies for example south of the west end of Makataiamik Lake, and as stock-like bodies, for example the elliptical intrusion underlying the western end of Makataiamik Lake.

The rocks are characterized by porphyritic feldspar and in some instances,

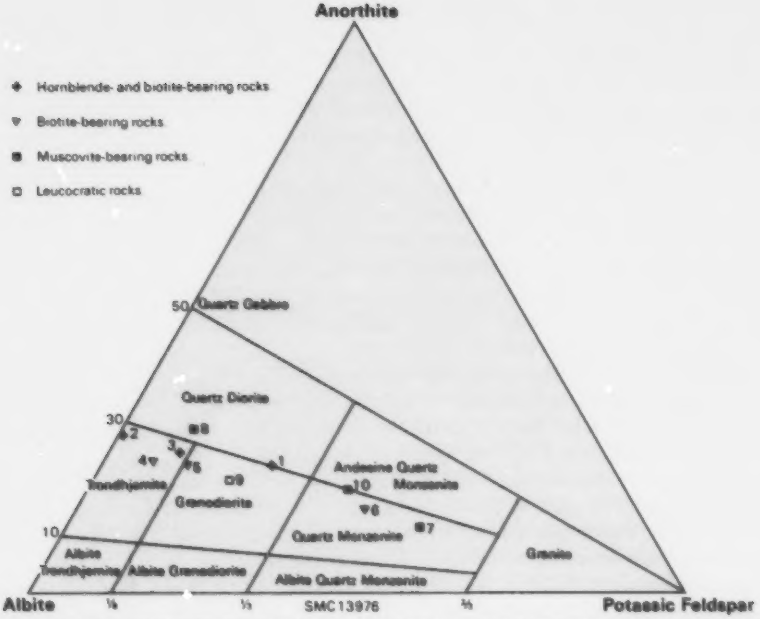

Anorthite
◆ Hornblende- and biotite-bearing rocks
▼ Biotite-bearing rocks
■ Muscovite-bearing rocks
□ Leucocratic rocks
50
Quartz Gabbro
Quartz Diorite
30
2
■8
3
4▼
1
5
Trondhjemite
□9
Granodiorite
Andesine Quartz Monzonite
10
▼6
■7
Quartz Monzonite
10
Albite Trondhjemite
Albite Granodiorite
Albite Quartz Monzonite
Granite
Albite
⅛
⅓
SMC13976
⅔
Potassic Feldspar

Figure 11–Classification of granitic rocks (after Ayres 1972), and plot of modally analyzed granitic rocks from the Hewitt Lake Area. Numbers refer to columns in Table 6. Crosses represent hornblende- and biotite-bearing rocks; inverted open triangles, biotite-bearing rocks; black squares, muscovite-bearing rocks; and open squares, leucocratic rocks.

porphyritic hornblende. The larger bodies such as the Makataiamik Lake Stock are more equigranular, and have textures that resemble those of the batholithic rocks. No genetic relationship has been established by the author between the granitic batholithic rocks and the metamorphosed stocks in the map-area. Although no chemical consanguinity has been established at the time of writing between extrusive rocks and intrusive stocks within the map-area a close spatial association apparently exists between them. A chemical similarity appears to exist between these rocks in the area to the north (Wood 1977). The Makataiamik Lake Stock will be discussed separately from the other metamorphosed felsic to intermediate intrusive rocks because it is a relatively large discrete body.

The classification used in this report for the granitic rocks is illustrated in Figure 11.

Porphyritic Microtrondhjemite and Microdiorite

In the map-area, these rocks have been subdivided into two mappable groups. Micro-trondhjemite has plagioclase phenocrysts and microdiorite has

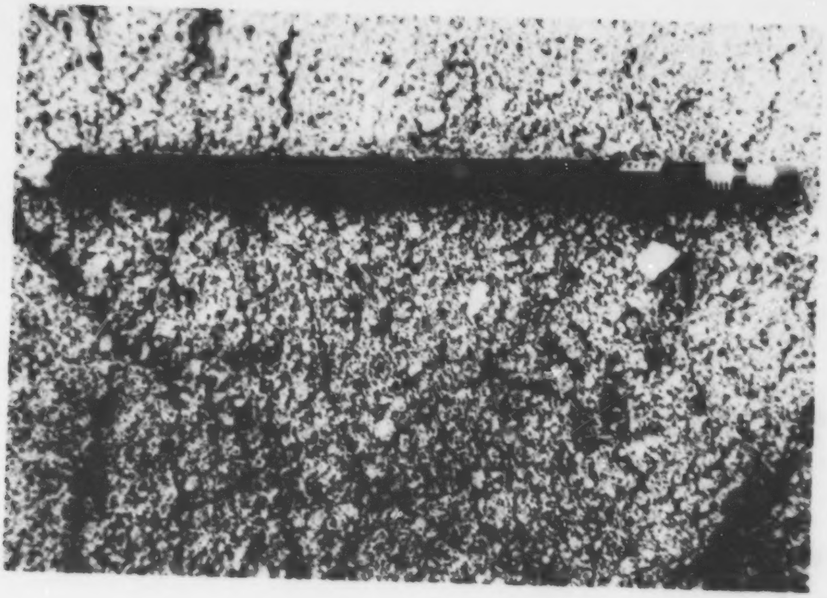


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Photo 17–Porphyritic microtrondhjemite from near Wokokotai Lake. Feldspar phenocrysts vary in size and in shape. The pencil is 15 cm long.

feldspar and ferromagnesian (originally hornblende) phenocrysts.

The distribution of the porphyritic feldspar-bearing rocks can readily be appreciated from the accompanying map (Map 2408, back pocket). As mentioned in the section on felsic to intermediate metavolcanics "overlap" exists in the mapping of intermediate pyroclastic and subvolcanic intrusive rocks. The genesis of these two types of rocks is related because the pyroclastic rocks are the extrusive equivalent of the subvolcanic rocks, thus the two types can occur in a close spatial association and often show similar textures. In localities in the map-area where porphyritic microtrondhjemite forms small dikes or sills, the rock is indubitably intrusive. In the larger bodies such as those near Wokokotai Lake, the intrusive or extrusive nature may not be obvious. Since such occurrences are probably complexes of intrusive and extrusive character, the decision to name them as extrusive or intrusive was based on their relationships with the adjoining rocks. If the body of intermediate rock in the field was discordant, it was described as intrusive, if no discordancy was observed, it was described as extrusive.

The porphyritic microtrondhjemite invariably weathers to a light buff colour, the more mafic microdiorite varieties weather slightly darker. The mafic phenocrysts weather black, the feldspar phenocrysts weather off-white and vary in size from about 1 mm in the small intrusions to greater than 1 cm in the larger bodies. Photo 17 illustrates part of a porphyritic microtrondhjemite outcrop on the northeastern shore of Wokokotai Lake. The large crystals in the photograph are feldspar, and have a different size and shape; some are euhedral, some appear to have had corners broken off. On such rock exposures elliptical patches of biotite several mm long are common and presumably represent altered amphibole. Outcrops such as the one illustrated may also contain large elliptical fragments of rock, the composition of which, as far as could be determined on outcrop, are virtually identical to the enclosing rock. Maximum length of the fragments is about 30 cm, average length about 10 cm. The density of fragments is variable, on some outcrops it is zero, on other outcrops it is several percent, on a few outcrops it is 50 or more percent. The rock outcrops with a high fragment density resemble a pyroclastic rock. Where the fragment density is low, the rock appears to be igneous with inclusions of early crystalline phases.

The porphyritic intrusive rocks have been folded along with their host rocks and are foliated. The intensity of the foliation is variable from outcrop to outcrop and reflects variations in tectonic effects within the map-area.

Thin section examination reveals that the porphyritic texture of the porphyritic microtrondhjemite is striking. The size of the feldspar phenocrysts is variable, but the groundmass is uniformly fine grained and ranges from 0.02 to 0.04 mm. Plagioclase phenocrysts generally constitute between 30 and 50 percent of the rock and are altered to sericite and epidote. Where visible, twinning indicates plagioclase has an albitic composition. Remnants of normal zoning can be detected. In the mafic microdiorites, clumps of green biotite are interpreted to represent altered hornblende phenocrysts, some of the biotite crystals are altered to chlorite. The groundmass is composed of the following: feldspar, albitic plagioclase (40 percent); quartz (35 percent), muscovite-sericite (15 percent); biotite and chlorite (7 percent); carbonate (2 percent); sphene, apatite, and opaques (1 percent); much of the muscovite-sericite and carbonate are an alteration product of feldspar. The feldspar in the groundmass cannot be readily identified under the microscope, amaranth red staining was used to determine the feldspar to quartz ratio. From the feldspar phenocrysts it is inferred that most of the feldspar is plagioclase. A compositional spectrum exists between porphyritic microtrondhjemite and porphyritic microdiorite. Much of the intermediate to felsic metavolcanic sequence has a comparable mineralogical composition.

Porphyritic Microgranite (Quartz Porphyry)

One quartz porphyry was located by the field party in the map-area; it is located just south of the western end of Makataiamik Lake where it has intruded a conglomerate along an outcrop edge. The dimensions of the intrusion which is concordant to subconcordant are not known. The rock is siliceous tough and splintery when hammered, weathers to a very light cream, and contains pyrite and arsenopyrite visible on outcrop surfaces. From thin section inspection, the rock matrix has a grain size exceeding 0.1 mm, the minerals are polygonized and have a granoblastic texture. Quartz is the predominant rock component (65 percent) and the rest of the rock consists of: feldspar, microcline and possibly plagioclase (20 percent); muscovite (10 percent); clinozoisite (2 percent); opaque minerals (2 percent); garnet and sphene (about 1 percent). It has no apparent genetic relationship to other rock types in the map-area.

Makataiamik Lake Stock (Biotite Trondhjemite, Granodiorite)

This intrusion, underlies an elliptically-shaped area 4 km long and 1 km wide near the western end of Makataiamik Lake.

The intrusion is generally fine to medium grained, equigranular to porphyritic, and foliated. Minor disseminated pyrite was observed on outcrops of this intrusion near its northern boundary. Several dikes of feldspar porphyry texturally similar to the stock occur in the vicinity of the western end of Makataiamik Lake and may be genetically related to the stock.

On the weathered surface, the rocks of the stock are a light buff to grey. Thin section examination reveals that the rock has a weakly developed porphyritic texture. Equigranular plagioclase with a grain size around 2 mm is set in a groundmass of granular quartz and microcline grains about 0.3 to 0.5 mm in diameter. The microcline is completely unaltered, but the plagioclase is highly altered to albite, sericite, and carbonate. Hornblende is pleochroic in shades of green, and is the principal mafic mineral; in places it is altered to biotite and chlorite. Irregular granulated crystal outlines suggest that it has undergone deformation. Apatite, sphene, and opaque minerals are accessories.

A foliation is present in the rock; thin section examination reveals that it is defined by the alignment of plagioclase crystals in the enveloping granular quartz and microcline. Although the deformation appears to be cataclastic, the differences in grain size and alteration between the microcline and plagioclase cannot readily be explained by cataclasis alone. If the plagioclase and microcline crystallized, at approximately the same time, the plagioclase has been preferentially altered. Alternatively, the microcline may have been introduced after the plagioclase crystallized, at the same time as, and perhaps by a process related to, either the quartz granulation or the plagioclase alteration.

The rock type comprising this body is classified as a biotite-hornblende granodiorite but compositionally is close to a biotite hornblende trondhjemite.

Despite the low outcrop density in the vicinity of the western part of Makataiamik Lake, the stock has apparently forcefully emplaced itself by pushing apart the metavolcanic and metasediments. If the intrusion were to be removed, and the metavolcanics and metasediments immediately north of the intrusion reoriented in strike direction towards the southeast, these rocks would be aligned with similar rocks along the southern shore of Makataiamik Lake.

BATHOLITHIC GRANITIC ROCKS

The batholithic granitic rocks underlie a large part of the map-area and occupy an area almost equal in size to the part underlain by rocks of the metavolcanic-metasedimentary belt. Wherever these granitic rocks outcrop adjacent to rocks of the metavolcanic-metasedimentary belt, the contact is intrusive. No

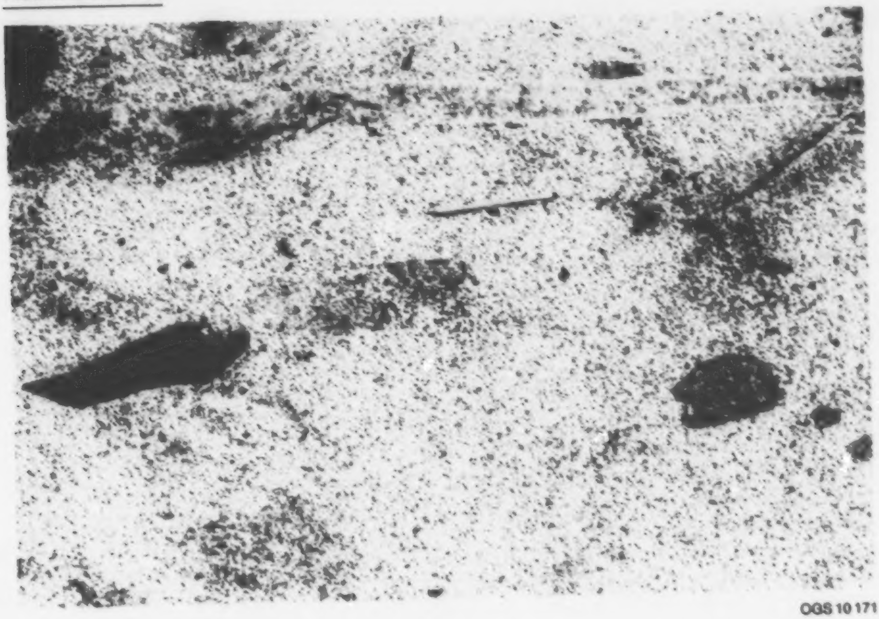
OGS 10 171

Photo 18–Outcrop relationships of some granitic rocks. An explanation is given in the text, in the section on "Batholithic Granitic Rocks". The pencil is 18 cm long.

unconformable relationships between granitic and metavolcanic or metasedimentary rocks were observed. In some localities in the western half of the map-area, particularly near the Margot Lake body, the metamorphic grade of the metavolcanic-metasedimentary rocks varied according to their proximity to the granitic rocks. No such simple relationship was observed in the eastern half of the map-area.

In the field, the rocks were mapped according to texture (that is, porphyritic or equigranular) and mineralogical composition. The presence of a foliation was not considered a significant factor in the determination of age relationships between rocks since there are many faults which have intensely foliated some of the granitic rocks on a local scale. The only parameter on which age relationships can be based is cutting relationships between lithologic units.

Photo 18 shows the type of relationships that can be observed within a small area on a given outcrop. The main mass of granitic material in Photo 18 is a biotite-hornblende granodiorite. Black inclusions of mafic rock, presumably mafic metavolcanics are enclosed in the granodiorite. The large inclusion towards the left of the photo has a very thin ferromagnesian border and shows little feldspar development within it. Just below the pencil point is another inclusion presumably of an initial composition similar to the first, but shows the development of feldspar porphyroblasts within it. The large inclusion in the right of the photograph shows similar textures. Between these inclusions there is a grey area which represents an inclusion which has been almost totally assimilated into the granodiorite; several such inclusions can be seen in the photograph. Where the inclusions are almost totally assimilated, the granodiorite is hornblende rich. The exact process whereby some inclusions become totally assimilated and others only partly assimilated is rather unclear. The high hornblende content of areas where the inclusions are almost wholly assimilated would preclude a more felsic composition for assimilated inclusions and a more mafic composition for non-assimilated inclusions. A small pegmatite dike cuts the inclusions and the granodiorite. The resolution of the complex relationships of the granitic rocks on the scale of the map would require much study and time.

The granitic rocks show distinct regional variations, thus the rocks south of Cam Lake and southwest of the contact with the North Spirit Lake Belt are largely hornblende and biotite bearing. Those granitic rocks around Cam Lake and in the vicinity of Margot Lake are biotitic as are most of the granitic rocks east and northeast of the northeastern contact with the North Spirit Lake Belt.

The classification of the granitic rocks is illustrated in Figure 11 and follows that of L.D. Ayres (1972). When two modifiers are used, for example hornblende-biotite, the order of modifiers indicates that biotite is more abundant than hornblende, this follows the suggestion of D.M. Shaw (1957).

The different granitic rock types will be discussed beginning with the more mafic members.

Hornblendic Rocks

Diorite, Quartz (Biotite) Diorite, Mashkik Lake, and Makataiamik Lake Occurrences

Dioritic rocks were found near Hewitt Lake, near Mashkik Lake, and about 2.5 km northeast of Makataiamik Lake.

At the Mashkik and Makataiamik Lake Occurrences, the rocks are hybrids because they are not compositionally uniform. Two compositionally distinct phases can be recognized in thin section. Inclusions of mafic rocks often occur, for example northeast of Makataiamik Lake. Transitional to these mafic inclusions is diorite. The author considers that the dioritic rocks are therefore the result of the interaction of a more felsic magma with more mafic rock. Similar conclusions regarding the origin of dioritic rocks were reached in another area mapped by the author (see Wood 1971).

The dioritic rocks are characterized by large dark green to black amphibole crystals, up to 4 mm in length, and rounded or stumpy in habit; and feldspar, around 2 mm in length which may be reddish, pink, or grey. In some localities, such as parts of the Mashkik Lake occurrence, a finer grained, less than 0.3 mm in maximum dimension, quartzofeldspathic phase is present.

In a thin section from a sample from near Mashkik Lake, the large green amphibole crystals have a poikiloblastic appearance. Within one large crystal there are smaller amphibole crystals and remnants of other colourless crystals some of which have a similar crystallographic orientation to the large green crystals. The pleochroic scheme of the outer parts of amphibole crystals is light to dark green, whereas the inner parts of a crystal are generally colourless to very pale green, the amphibole crystals are probably hornblende. Some of the amphibole crystals show several stages of growth in the form of growth rings in their outer margins. The colourless crystals were identified as pyroxene (augite), the maximum measured extinction angle is 43°, and the optical sign positive. The large feldspar crystals are albite and contain large amounts of epidote and sericite, the original composition was probably much more calcic. Crystals are granulated and have indistinct boundaries. The finer grained part of the rock is composed mainly of the following: untwinned and twinned crystals of oligoclase which are partly altered to epidote and to a lesser extent to sericite; microcline (unaltered) biotite (light green) and quartz. Other minerals in the rock are: sphene, epidote, magnetite, zircon, and apatite.

The texture and mineral assemblages visible in thin section reinforce the field observation that the rock is of hybrid origin. Clinopyroxene crystals indicate that the original rock type was gabbroic and that its present texture and composition is a consequence of the interaction of the gabbroic rock with a water undersaturated magma of quartz monzonitic composition. Diorite and quartz diorite are considered by the author to be the most appropriate names for these rocks; quartz diorite having greater than 5 percent quartz, the diorite less than 5 percent quartz.

Hewitt Lake Occurrence

The dioritic body north of the western arm of Hewitt Lake does not fit in the same category as the two occurrences described. The dioritic body north of Hewitt Lake postdates most of the fold structures in the metasediments. This body has been foliated although not to the same intensity as the metasediments. The intrusion has no apparent genetic relationship to the granitic batholithic rocks. Plagioclase in the intrusion is strongly zoned suggesting a relatively rapid cooling history not comparable to the slow cooling of the granitic batholithic rocks which show only minor zoning in plagioclase. The author considers that the intrusion, because of its unmetamorphosed character can be classifed more appropriately with the batholithic granitic rocks than with the subvolcanic rocks.

The dioritic body north of Hewitt Lake is a high-level intrusion. Apophyses of the intrusive material occur in the adjoining metasediments. Inclusions of metasediments occur in the border zones and central parts of the intrusion. In the central part of the outcrop area underlain by the intrusion, intrusive breccias are common. The breccia blocks in the intrusive breccia are composed of fine-grained dioritic material thought by the author to be blocks of the border phase of the intrusion. The border phase may be the roof or the sides of the body depending on the orientation of the body as it is now seen.

In the field, the rocks of this intrusion are mottled pink-brown and black and have an unmetamorphosed appearance. In some parts of the occurrence, the rocks appear massive, in others foliated. The author concludes that the foliation is more a function of dynamic rather than dynamothermal metamorphism.

Thin section examination reveals that the rocks appear medium to fine grained, equigranular, and massive. Minerals present include plagioclase which is strongly zoned. The zoning is normal in that the borders of any one crystal are more albite rich than the core. Within this overall normal trend, the zoning is both oscillatory and discontinuous. The anorthite content of the cores of crystals measured are as much as 55 percent. The border compositions could not be determined accurately. The author estimates that the border zones are either composed of oligoclase or albite. The average feldspar composition is therefore probably andesine. Plagioclase constitutes about 65 percent of the rock, other minerals present are: hornblende, pleochroic light to dark green (10 percent); quartz (10 percent); biotite, pleochroic light to dark brown (10 percent); and epidote, sphene, zircon, and opaque minerals comprise the rest of the rock. The proportion of the main minerals varies slightly from place to place. This variation, in particular the biotite content is depicted on the accompanying map by the different codes (Map 2408, back pocket). The breccia blocks are, as mentioned, finer grained and composed predominantly of hornblende. As far as can be determined, the composition of the plagioclase is in the andesine-labradorite range. This affirms the suggestion that the blocks originated as an early crystalline phase of the rock body. The rock types in this body are quartz diorite and quartz (biotite) diorite.

Porphyritic and Equigranular Hornblende-Biotite Trondhjemite, Granodiorite; Porphyritic and Equigranular Biotite-Hornblende Trondhjemite, Granodiorite

These rock types are separated on the map-legend in order that their areal distribution on the map (Map 2408, back pocket) can be outlined. Petrographically they are similar, and genetically are probably closely related to each other. Therefore to avoid repetition of descriptions, they are grouped together in the text.

Most occurrences of these rocks are southwest of the boundary with rocks of the metavolcanic-metasedimentary belt. There are a few small outcrops of equigranular hornblende-biotite trondhjemite, and equigranular hornblende-biotite granodiorite about 1500 m northeast of Makataiamik Lake, where these rock types appear to form a transitional phase between quartz diorite, biotite quartz monzonite, and granodiorite. The following parts of this section of the report relate to the rocks in the southwestern part of the map-area.

The subdivision of the hornblende- and biotite-bearing granitic rocks is based on field observation. The accompanying map (Map 2408, back pocket) indicates the distribution of the different mineralogical and textural features in these rocks. Those rocks in the extreme southwestern corner of the map-area are hornblende- and biotite-bearing types, and those near the metavolcanic-metasedimentary contact and south of Cam Lake are mostly biotite- and hornblende-bearing types. This variation suggests a mafic to felsic trend towards the northeast. The existence of hornblende free rocks around Cam Lake reinforce such a suggestion.

Most of the rocks can be described as porphyritic because the feldspar crystals are markedly larger than the quartz or ferromagnesian crystals, but are not larger than each other. The rocks are medium grained and grey to flesh coloured. As a rule, granodiorite is an overall flesh colour and trondhjemite grey, however, exceptions do occur. The ferromagnesian minerals are all dark green.

Foliation is generally indistinct and is expressed by an alignment of minerals, principally the ferromagnesian minerals. Near the contact with the metavolcanics and metasediments, foliation becomes more intense, and where the contact is closely approached, granulation of the granitic rocks and epidote veining is visible. Except for a small pegmatite dike in mafic metavolcanics northwest of Nipa Lake, no unequivocal evidence of an unfaulted intrusive contact between the main mass of hornblende-bearing granitic rocks and the metavolcanics was observed. South of Little Hewitt Lake, hornblende- and biotite-bearing granitic rocks contain inclusions of metavolcanics and metasediments, however, the stratigraphic relationship of these granitic rocks to those granitic rocks in the southwest is not known because of faulting.

Thin section examination reveals the equigranular and porphyritic textures. Phenocrysts in the porphyritic trondhjemitic rocks are plagioclase, those in the porphyritic granodioritic rocks are plagioclase or plagioclase and microcline. The feldspar crystals are euhedral to sub-euhedral; crystals of quartz, amphibole, and other minerals are interstitial to the feldspar. The indistinct foliation seen on outcrop is not readily visible on a microscopic scale.

Minerals occurring in the trondhjemitic and granodioritic rocks are: quartz, oligoclase, hornblende (pleochroic from straw yellow to dark green), biotite (pleochroic from straw yellow to dark green), microcline, epidote, sphene, apatite, zircon, and opaque minerals.

The amounts of these minerals in three thin sections point-counted are given in Table 6. The modal analyses in Table 6, columns 1 to 3 indicate that there is a decrease in the amount of ferromagnesian minerals with increasing microcline content. One aspect of the mineralogy is the similiar colour of biotite and hornblende. Care is needed during fieldwork to avoid confusion between them. Figure 11 shows diagrammatically the location of these granitic rocks on an Albite-Anorthite-Microcline triangular diagram.

Quartz-feldspar pegmatite intrusions varying in size from a few centimetres to metres in width and of undetermined length, are present throughout the area underlain by the hornblende- and biotite-bearing intrusive rocks.

Biotitic Rocks

Within the map-area, the biotitic rocks can with one exception, be conveniently discussed in three groups based on geography and geology. The three groups occur as follows: a) southwest of the fault passing through rocks underlying Nipa, Mashkik, and Cam Lakes; about Margot Lake and between the three faults north of Cam Lake; and east of the metavolcanic-metasedimentary belt. The one exception to this grouping is the garnetiferous pegmatite southeast of Mashkik Lake.

TABLE 6 MODAL ANALYSES OF GRANITIC ROCKS, HEWITT LAKE AREA.

Column	1	2	3	4	5	6	7	8	9	10
Sample Number	F-72-61	F-72-34	F-72-48	F-72-6	W-72-17	R-72-190	W-72-62	W-72-57	H-73-69	H-73-104
Mineralogy:										
Plagioclase	50.0	58.5	47.0	52.0	51.0	34.5	30.4	55.0	56.2	33.4
Microcline	17.5	1.0	6.0	4.2	7.5	26.0	36.2	6.8	15.4	22.6
Quartz	13.5	12.5	15.5	22.0	26.0	32.2	28.6	30.0	22.0	41.2
Biotite-chlorite	7.0	13.5	7.0	18.8	12.0	6.8	3.0	—	3.2	1.4
Hornblende	8.0	11.0	21.0	—	1.0	Tr.	—	—	—	Tr(?)
Epidote	4.0	3.0	2.0	1.8	2.0	1.1	—	—	0.6	Tr
Muscovite	—	—	—	—	—	—	1.2	8.0	—	1.4
Carbonate	—	Tr	—	—	Tr	—	—	—	—	—
Apatite	—	Tr	Tr	Tr	Tr	Tr	—	—	Tr	—
Zircon	—	—	Tr	Tr	—	—	—	—	—	—
Sphene	Tr	0.5	0.8	0.8	Tr	Tr	—	—	1.1	Tr
Iron-Titanium Oxide	Tr	0.5	0.7	Tr	Tr	0.5	—	—	1.1	—
Garnet	—	—	—	—	—	—	Tr	0.2	—	Tr
Plagioclase composition	An_{30}	An_{28}	An_{28}	An_{25}	An_{26}	An_{26}	An_{25}	An_{32}	An_{25}	An_{30}
$\frac{\text{Microcline}}{\text{Total Feldspar}}$	0.26	0.002	0.11	0.07	0.13	0.43	0.54	0.11	0.21	0.40

Rock Name:

1. Hornblende-biotite granodiorite
2. Biotite hornblende trondhjemite
3. Hornblende biotite trondhjemite
4. Biotite trondhjemite
5. Biotite (hornblende) granodiorite
6. Biotite quartz monzonite
7. Biotite muscovite quartz monzonite
8. Muscovite garnet pegmatite
9. Leucocratic biotite granodiorite
10. Leucocratic garnet-biotite-muscovite quartz monzonite

Abbreviations:
Tr - Trace amounts detected
— - Not detected

Biotitic Granitic Rocks Southwest of Cam, Mashkik, and Nipa Lakes

Porphyritic and Equigranular Biotite Trondhjemite, Granodiorite

Except for the absence of hornblende, the biotitic rocks which occur in the southwestern part of the map-area are similar to the biotite hornblende and hornblende-biotite granitic rocks from the same parts of the map-area. For a general description of the rocks as seen on outcrop, the reader is referred to the section of the report dealing with the hornblende- and biotite-bearing granitic rocks.

Except for the absence of hornblende, the mineralogy of the biotitic rocks is similar to the hornblende- and biotite-bearing varieties. A modal analysis of minerals from a thin section of a sample taken from west of Cam Lake is given in Table 6, column 4. On an Albite-Anorthite-Potassic Feldspar classification diagram (Figure 11), this sample plots in the trondhjemite field. Although statistically unsupported because of the paucity of analyses, there is a suggestion from Figure 11 that the biotite-bearing samples have less anorthite than hornblende- and biotite-bearing samples.

The similarities between the biotite-bearing and hornblende biotite-bearing granitic rocks in the southwestern part of the map-area strongly suggest that the two rock types are genetically related.

Pegmatite and Aplite

Pegmatite and aplite dike-like intrusions are common in the southwestern part of the map-area. Pegmatite and aplite are pink and have a simple feldspar-quartz mineralogy; frequently, the amount of quartz is low. There were probably several phases of intrusion since on some outcrops pegmatites crosscut each other. In the time available the pegmatitic intrusions could not be correlated to other granitic intrusive phases.

Biotitic Granitic Rocks of the Margot Lake Intrusive Body

The biotitic granitic rocks which occur near Margot Lake are characterized by small amounts of ferromagnesian minerals and large amounts of feldspar as can be seen from Table 6, columns 5 to 7 which give mineral-frequency modal analyses of three rocks from near Margot Lake. The maximum total percentage of ferromagnesian minerals in the three examples listed is 13 percent contrasting with analyses of rocks from the southwestern part of the map-area. The small amount of ferromagnesian minerals is apparent on outcrop because all of the granitic rocks are light coloured.

All the granitic rocks of the Margot Lake Intrusive Body are foliated. Most of the foliations parallel the contacts with the adjacent metavolcanic-metasedimentary rocks. Near the southeasterly end of the granitic body, the predominant foliation has a northwest trend and forms angles of up to 90° with the contact direction. This suggests that the foliation either has been superimposed by faulting or is an expression of an episode of folding which has occurred after emplacement of the granitic rocks.

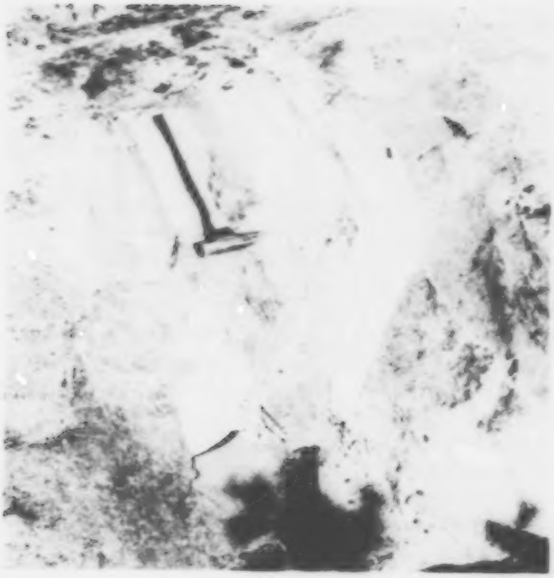

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Photo 19–*Lit-par-lit* injection of metasediments by granitic material. Note the thin quartz feldspar veinlets in the top right corner of the photograph. The hammer handle is 33 cm long.

The granitic rocks of the Margot Lake Intrusive Body are unique in the map-area because they are intimately associated with highly metamorphosed supracrustal rocks. Around the shoreline of Margot Lake, there has been *lit-par-lit* injection of highly metamorphosed supracrustal rocks by granitic material (Photo 19). On the north shore of Margot Lake west of the Flanagan River there is a complete gradation from granitic material into schists with relict bedding. At the extreme top right of Photo 19, small discontinuous quartzofeldspathic veinlets can be seen. These veinlets appear to represent mobilizate resulting from metamorphism of the sedimentary rocks.

Just to the south of Margot Lake there are many metasedimentary inclusions in the granitic body. The number of metasedimentary inclusions decreases in a southeastward direction away from Margot Lake.

Porphyritic and Equigranular Biotite-Hornblende Quartz Monzonite, Granodiorite

These rock types constitute much of the Margot Lake Intrusive Body. During field mapping no distinctive characteristics were noted which would serve to distinguish different rock types. Examination of two thin sections from two samples indicate that one sample is a granodiorite, the other a quartz monzonite. The most noticeable difference between the two rock types is a lower percentage of ferromagnesian minerals in the quartz monzonite (compare columns 5 and 6 in Table 6). Detailed mapping combined with staining of hand samples for feldspar identification would probably result in resolution of the different intrusive phases. On the weathered surface these rocks are flesh to grey coloured; dark green spots represent the ferromagnesian minerals.

Minerals identified from examination of thin sections are: oligoclase, quartz, microcline, and biotite, with accessory amounts of hornblende, epidote, sphene, apatite, magnetite, and chlorite. The percentages of the minerals present are given in columns 5 and 6 of Table 6. In both rocks, the minerals show little alteration except for a fuzziness in the plagioclase indicating incipient alteration to epidote and albite, and minor chloritization of the straw yellow to dark green biotite. In the porphyritic varieties, the phenocrysts are oligoclase, but as in the porphyritic rocks in the southwestern part of the map-area, the phenocrysts are only slightly larger than crystals of the other minerals in the rocks. In the thin section of granodiorite, quartz has been granulated, individual crystals are strained and have a grain size of 0.1 to 0.2 mm compared to the feldspars which are as long as 0.5 cm. In parts of this same thin section, there are narrow sinuous bands of granulated quartz, suggesting that the foliation in the rock is at least partly cataclastic.

Miscellaneous Batholithic Granitic Rocks

Garnet-Biotite-Muscovite Quartz Monzonite

This rock type is best developed west of the Flanagan River between Cam and Margot Lakes, although there are occurrences north and south of Margot Lake. The rock is foliated and white to flesh coloured. The flesh colouration is given by potassic feldspar crystals some of which are up to 5 mm in length, thus imparting a porphyritic texture to the rock. Although somewhat small in size, garnets are about 1 mm in diameter, and are easily recognizeable on outcrop because of the contrast between their dark red colour and the lighter coloured quartzofeldspathic minerals comprising the remainder of the rock.

The leucocratic nature of the rock is very distinct, in thin section, ferromagnesian minerals are rare and form only small crystals. Minerals are: microcline; oligoclase; quartz; muscovite; biotite, pale to medium green-brown; chlorite, pale green to green-grey; sphene; epidote; and apatite. Percentages of the minerals are given in column 7, Table 6. Quartz and feldspar account for more than 95 percent of the rock. Thin section examination reveals parallel zones of granulated quartz and feldspar traversing the slide, these indicate the rock has undergone considerable deformation.

White Garnetiferous Pegmatite

This pegmatite which is a brilliant white colour, occurs north and south of Margot Lake and southeast of Mashkik Lake. The rock generally forms dikes, but in some instances, such as near Mashkik Lake, it forms larger pod like bodies.

Minerals in thin section are oligoclase, andesine, quartz, muscovite, microcline and garnet; the percentage of the minerals present are given in Table 6, column 8. Quartz crystals are strained and have undulose extinction, and many plagioclase crystals are bent. These features indicate that the pegmatite has been subjected to deformation. The rock plots in the quartz diorite field (Figure 11). Compared to other granitic rocks in the map-area, the plagioclase is very calcic. Another anomaly, though, is the large amount of muscovite and the relative scarcity of microcline; most of the other granitic rocks show the opposite relationship (see Table 6).

Pink Pegmatite; Aplite

These two rock types are common in the area underlain by the Margot Lake Intrusive Body. Aplite forms small dike-like intrusions generally less than 0.3 m wide and of indeterminate length. Although the pegmatite intrusions are also generally narrow, in the region north of Margot Lake and west of the Flanagan River pink pegmatite may form outcrop-size intrusions. The intrusions are predominantly feldspathic and are probably microcline rich from the colouration in outcrop. The petrology of pegmatite and aplite was not studied in detail.

Biotitic Granitic Rocks in the Eastern Part of the Map-Area

Extremely inclement weather conditions during the 1973 field season resulted in the rapid reconnaissance mapping of the granitic rocks in the eastern part of the map-area. The granitic rocks have a variable grain size, but are generally coarse grained, equigranular, or porphyritic in the southern three-quarters of this part of the map-area, and medium to coarse grained, porphyritic, or equigranular in the northern quarter of this part of the map-area. Textural variations from porphyritic to equigranular, or coarse grained to medium grained are gradual, and do not appear to be attributable to separate intrusions. On outcrop, the granitic rocks are massive and unfoliated in most occurrences, where foliated, the appropriate symbols are given on the map (Map 2408, back pocket). The composition of the biotitic granitic rocks shows little variation. Ferromagnesian minerals generally constitute less than 10 percent of the rocks, although near the dioritic occurrences northeast of Makataiamik Lake, values of 22 percent mafic minerals were noted during field mapping. Much of the granitic material in the northern part of the map-area is leucocratic.

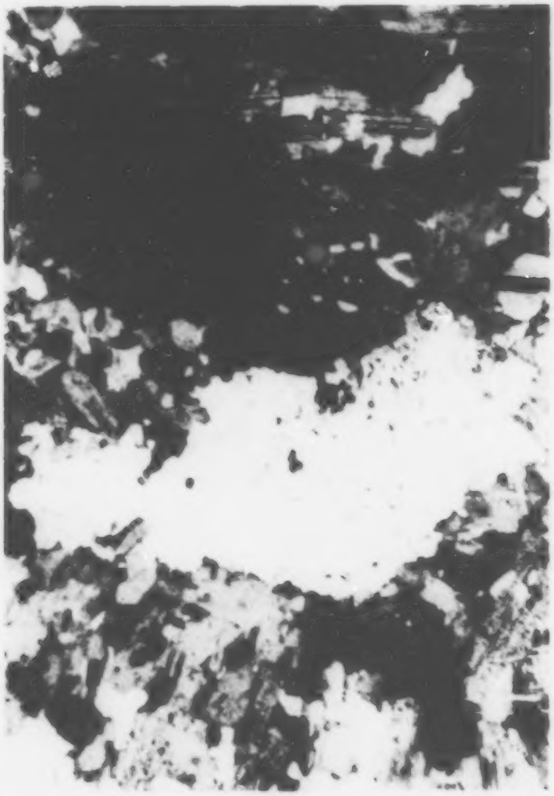

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Photo 20–Photomicrograph of deformed granitic rock. Note bent and broken albite twins in plagioclase and the granular boundaries between grains. Field of view is 2.5 mm.

Coarse-Grained (Equigranular or Porphyritic), Biotite Granodiorite

This rock type constitutes the most important rock type in the southern three-quarters of the eastern part of the map-area underlain by granitic rocks. The rock is everywhere coarse grained and almost always porphyritic. Phenocrysts may be either quartz or feldspar and are commonly 1 cm in length. On outcrop, the rock is flesh coloured and generally contains low amounts of mafic minerals. The appearance is massive on outcrop. Thin section examination reveals that the minerals show strain: the quartz grains are granulated, have sutured grain boundaries, and in one thin section are slightly flattened; feldspar crystals have bent lamellae, and although some crystals are euhedral, others have complex intergrain boundaries not normally observed in granitic rocks (Photo 20).

Minerals occurring in thin section are: oligoclase; quartz; microcline (perthitic); chlorite-biotite, almost all of the biotite has been altered to a pale green chlorite; muscovite-sericite; epidote; sphene; magnetite; and zircon. The proportions of the various minerals in a thin sectioned leucocratic sample are shown in column 9, Table 6. Plagioclase crystals have been slightly altered to albite, epidote, sericite; the microcline crystals are unaltered; biotite crystals are almost invariably altered to chlorite. It may be concluded that despite its outwardly massive appearance this rock type has undergone deformation and very low grade metamorphism.

Garnet-Biotite-Muscovite Quartz Monzonite

This rock type occurs in the most northerly part of the map-area and although it is texturally variable being porphyritic or equigranular, coarse or medium grained, from place to place, the rock is uniformly leucocratic. On outcrop the rock is light flesh to grey coloured due to the lack of ferromagnesian minerals. In some localities, the rock has a foliated appearance, in others, it looks massive. This massive appearance is illusory. All six thin sections of this rock examined indicate that the rock has been deformed; quartz crystals are strained and show sutured boundaries and undulose extinction with flattening in some instances, and feldspar crystals are strained, they have bent twin lamellae and crystals that show complex boundary relations with one another and other minerals.

The mineralogy as seen in thin section includes: microcline (perthitic), quartz, oligoclase, biotite, epidote, zircon, sphene, apatite, and opaque minerals. Two samples from 2.5 km north of, and 3.2 km north-northwest of, the western end of Makataiamik Lake are muscovite and garnet bearing. Porphyritic varieties of the quartz monzonitic rock have either quartz or microcline or both as phenocrysts. The relative percentages of the various minerals as measured in one thin section are given in Table 6, column 10.

Pegmatite, Aplite

Pegmatite and aplite in this part of the area are superficially similar to the pegmatite and aplite which occur in the southwestern part of the map-area.

LATE PRECAMBRIAN

Mafic Intrusive Rocks

Diabase

One unmetamorphosed diabase dike occurs in the map-area north and south of Margot Lake. The rock is black, and the dike has a generally northerly trend. The rock is magnetic and should therefore be traceable by aeromagnetic techniques, but it is not readily apparent in ODM-GSC Aeromagnetic Map 867G (ODM-GSC 1960b). The dike is generally less than 30 m in width. Offshoots frequently occur, and one of these is illustrated in Photo 21. The age of the dike is not known. The dike can be traced from North Spirit Lake (Wood 1972a) to south of Little Hewitt Lake, and shows little offset over 10 km suggesting that it postdates almost all of the fault structures in the western part of the map-area. The nonfoliated nonmetamorphosed appearance of the rock would indicate that the dike is the youngest consolidated rock-unit in the map-area. The dike has chilled margins several centimetres thick.

In thin section, the rock is revealed to have an ophitic texture. Minerals present are: labradorite; pale green clinopyroxene (probably augite); brown to green hornblende; and minor amounts of biotite, quartz, and magnetite.

Phanerozoic

CENOZOIC

Quaternary

PLEISTOCENE AND RECENT

Within the map-area, no record remains of any geological events between the Precambrian and Cenozoic. During the Pleistocene Epoch, the area was glaciated during the late-Wisconsinan (Prest 1963). The glaciation is recorded in two ways; by the striation of outcrop surfaces and by the presence of sediments related to the processes of glaciation. Because the emphasis of the field-mapping was directed towards the Precambrian rocks, the Pleistocene sediments were not studied in detail.

The sediments overlie the Precambrian rocks with profound unconformity, and although they blanket much of the area, are poorly exposed. The nature of the sediments underlying swamp areas is not known. Several areas of sand and gravel were noted, principally northeast and southeast from the eastern end of

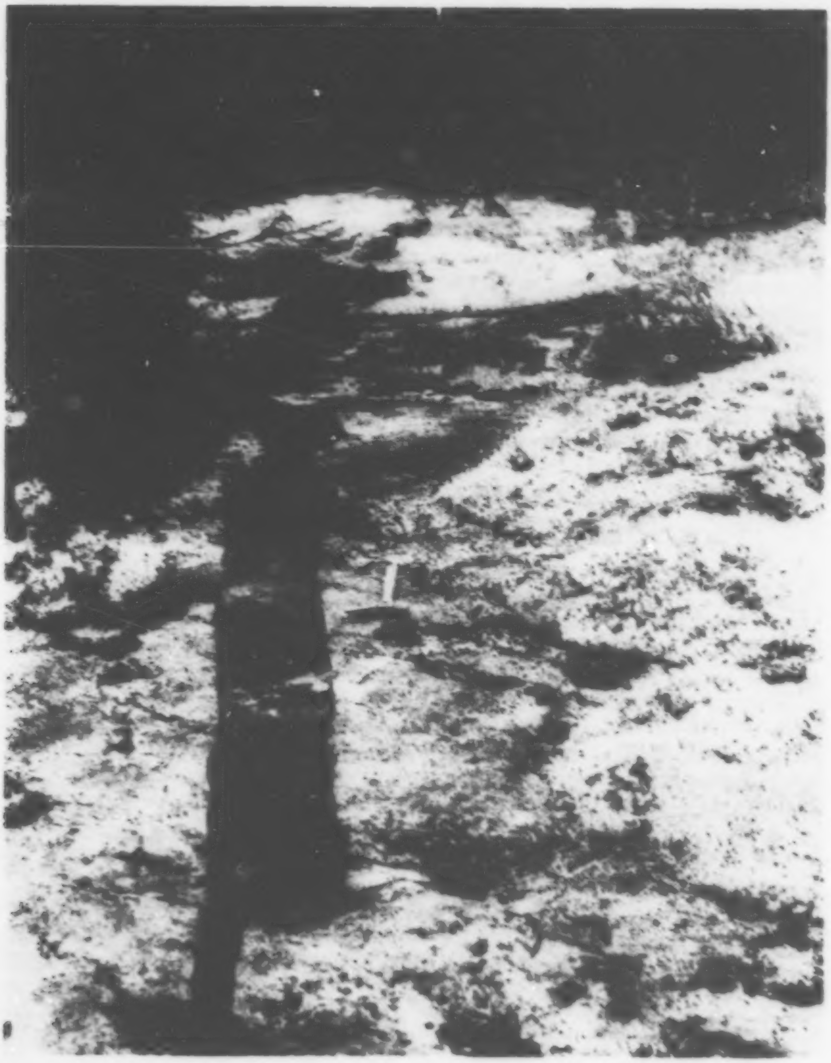

OGS 10 174

Photo 21–Small diabase dike. This occurs close to and parallel to the main dike. The hammer head is 15 cm long. Note the abundant moss cover on outcrop, a feature of almost all outcrops in the map-area.

Hewitt Lake. The potential of these areas as a source of sand and gravel is not known. A small sandy area is located on the northern shore of Hewitt Lake just west of the "V" in the lake.

No boulder till was identified, although till may underlie much of the map-area. Boulders and cobbles constitute the islands in the western part of Hewitt Lake. It is not known whether the boulders and cobbles were deposited as morainic material or were deposited as boulder till and subsequently had the fine-grained material washed out of them.

Small pits excavated by field party personnel adjacent to Little Hewitt, Hewitt, Makataiamik, Tahoe, and Nemakwis (just northeast of Wapisipi Lake) Lakes indicated that the sediments at the pit localities were bedded clayey silt probably of lacustrine origin. Beds were invariably less than 3 to 5.6 cm thick, and the material from the pits became extremely hard when exposed to the sun.

Processes of Recent sedimentation have done little except to locally redistribute Pleistocene sediments, particularly the finer grained material because river gradients are very low. Where visible, the bottoms of rivers and streams are composed either of sand or a thick glutinous mud.

STRUCTURAL AND METAMORPHIC GEOLOGY

Most of the rocks within the map-area have been metamorphosed, as indicated in the legend of the accompanying map (Map 2408, back pocket). A structural fabric has been imposed on these metamorphic rocks. A structural fabric has also been imposed on some of the unmetamorphosed granitic rocks, see the section on "Batholithic Granitic Rocks" and the foliation symbols on the accompanying map (Map 2408, back pocket).

During the field mapping schistosity was used in the sense of the Glossary of Geology, American Geological Institute, 1972;

> The foliation in schist or other coarse-grained crystalline rock . . . .

Thus the distribution of schistosity symbols on the accompanying map (Map 2408, back pocket) indicates, approximately, the areas of high grade metamorphism. Foliation symbols were used to signify foliations in the low grade metamorphic rocks which do not justify being called schist. The presence of a phyllitic texture was chosen as the cut off between the use of foliation and schistosity, a phyllitic rock being classified as having a schistosity.

Foliation symbols have been utilized on the map in both metamorphic and nonmetamorphic rocks, specifically in the granitic intrusive rocks. In the nonmetamorphosed rocks, the foliation is a result of either cataclastic deformation which has produced parallel planes of deformation without mineralogical change, or an orientation of minerals particularly ferromagnesian minerals, implying flowage during crystallization. Although the foliated metamorphosed rocks have in some localities undergone cataclastic deformation similar to the nonmetamorphosed rocks, they are distinct from the latter because their foliation is generally defined by recrystallized minerals.

Metamorphism

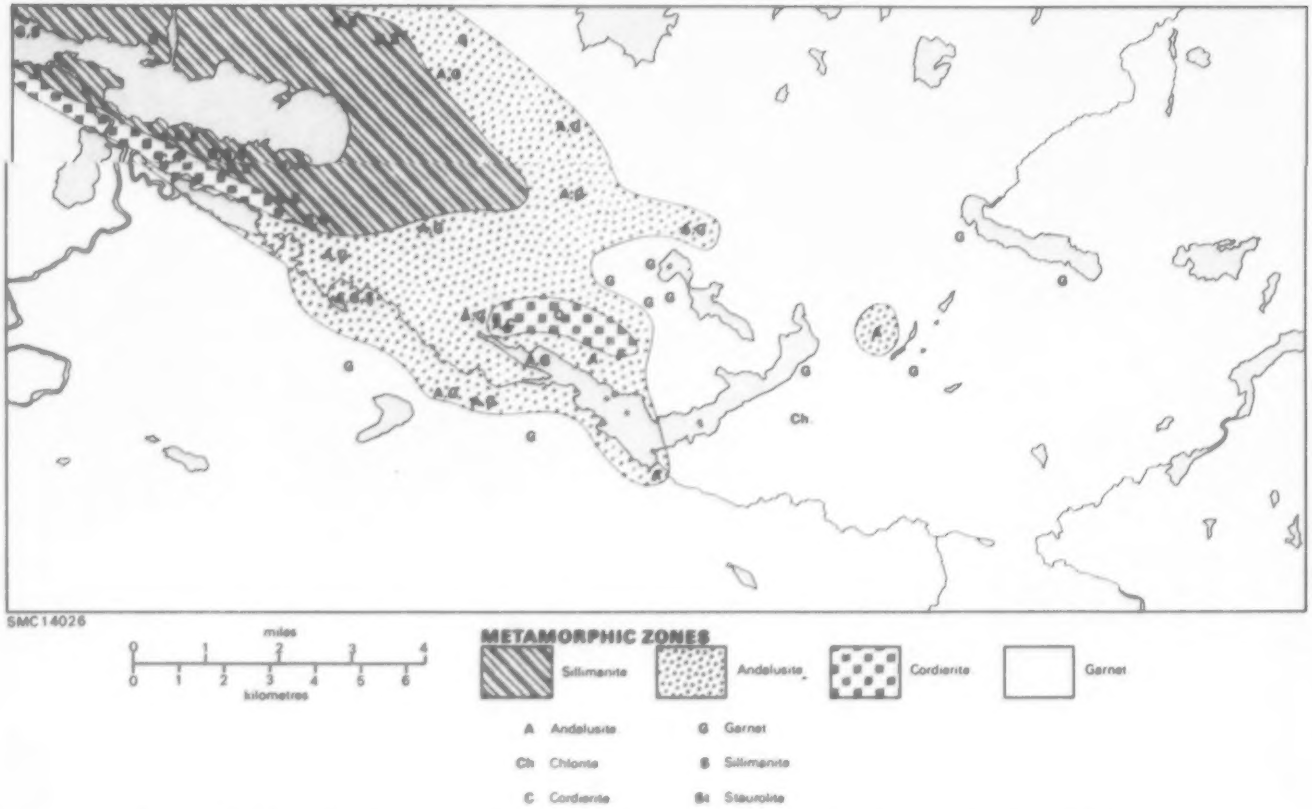
As indicated in the map-legend (Map 2408, back pocket), many of the rock types within the map-area have been metamorphosed. Of the many lithologies within the map-area, the clastic sedimentary rocks show most readily the effects of metamorphism by the development of metamorphic minerals, some of which can be used as metamorphic index minerals. To aid in appreciating the distribution of these minerals, localities where they have been found are shown in Figure 12. The most widely developed mineral is garnet, followed by andalusite, sillimanite, cordierite, and staurolite. As a further guide to the areal association of these minerals, lines have been drawn separating rocks containing sillimanite, cordierite (they are closely associated), andalusite, and garnet, or no index mineral. These lines effectively ignore fault induced variations. There appears to be a spatial association between the high grade sillimanite-, cordierite-, and andalusite-bearing metasediments and the Margot Lake intrusive body. No such simple relationship exists for the other granitic bodies in the map-area. There is therefore a possibility that the high-rank metamorphic rocks associated with the Margot Lake granitic body represent a contact metamorphic aureole.

No simple relationship can be inferred for the low grade metamorphism that has pervaded most of the supracrustal rocks and that consequently can be described as regional metamorphism.

A separation of the metamorphism in the area into contact and regional suggests that there are two separate metamorphic events. It is possible, however, that the contact and regional metamorphism all form part of one metamorphic episode, in which case a subdivision is unwarranted.

One of the characteristic features of the low grade metamorphic rocks is the abundance of biotite relative to chlorite in even the lowest metamorphic grades, this is illustrated qualitatively in Table 5. Such a distribution is uncommon in low grade regionally metamorphosed rocks which generally contain abundant chlorite (see Hyndman 1972, p.342), but occurs in rocks which have undergone low-grade dynamothermal metamorphism under conditions of low pressure (see Winkler 1967, p.84-93 and p.116-130). The mineral associations of the high-grade metasediments are not those of classical Barrovian metamorphism, but of Abukuma-type metamorphism (Miyashiro 1961); the temperature range is the same as in Barrovian-type metamorphism, but with a lower pressure (Winkler 1967, p.116). With the exception of the one occurrence of staurolite-bearing rock, all of the metamorphic rocks in the map-area can be satisfactorily classified in the Abukuma-type facies series. The staurolite occurrence may be the result of the local development of higher pressure during metamorphism. The lines joining localities of equal metamorphic rank in Figure 12 are effectively isograds which conform to the subfacies boundaries of the Abukuma-type facies series. Detailed work in the map-area might refine these boundaries and could provide insight into the relative post-metamorphic movement of the fault blocks in the map-area.

The textures observed in the high grade metamorphic rocks near the Margot Lake granitic body indicate that andalusite, cordierite, garnet, and sillimanite grew after the peak of tectonic deformation had passed, because in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kilometres
METAMORPHIC ZONES
Sillimanite
Andalusite
Cordierite
Garnet
A Andalusite
Ch Chlorite
C Cordierite
G Garnet
S Sillimanite
St Staurolite
A,G
G
Ch

Figure 12–The distribution of metamorphic index minerals in the Hewitt Lake Area. Garnet occurs only in areas designated 'G'.

schists these minerals occur as undeformed euhedral crystals; whereas the minerals of lower metamorphic rank, principally the micas, show evidence of deformation. From this it may be concluded that the peak of the thermal metamorphism affecting the rocks post-dated the peak of deformational intensity (compare Johnson 1962; Sutton 1965).

Several conclusions may be made regarding the metamorphism of the rocks in the map-area. These are:

1) The occurrences of high grade metamorphic rocks are spatially related to some of the granitic intrusive rocks;

2) The mineralogy of both the low grade and high grade metasediments is indicative of metamorphism under conditions of low pressure. The metamorphic rocks in the map-area can be more satisfactorily classified in the Abukuma-type facies series than in the Barrovian-type facies series;

3) No valid distinction can be made in the map-area between low grade "regional" metamorphism and higher grade "contact" metamorphism;

4) The climax of metamorphism post-dated the climax of associated deformation.

Structure

In the introduction to the chapter on "Structural and Metamorphic Geology" mention was made of the rock deformation in both the nonmetamorphosed and metamorphosed rocks. The deformation which affected the nonmetamorphosed rocks as well as the metamorphosed rocks is of a cataclastic nature, and occurred late in the geological history of the map-area. Most of the deformational structures within the map-area are related to dynamothermal metamorphism.

The tectonic analysis of any area requires many detailed observations uniformly distributed within that area. A tectonic analysis of the map-area was not possible because of the low density of outcrops and the non-uniform distribution of outcrops. Due to the meagre data, the conclusions presented here are highly interpretative.

So that the reader can understand individual structures within their setting, an outline of the general structural geology of the map-area follows. From mapping in the North Spirit Lake area (Wood 1977), and the mapping done by the field party in the map-area, it is apparent that the major part of the North Spirit Lake Belt is bounded by faults to the north and west. These faults form part of a system of faults extending from beyond Favourable Lake about 80 km to the northwest of the map-area to south of MacDowell Lake some 24 km to the south of the southeast corner of the map-area (Ayres *et al.* 1972). The author proposes to call this the "Favourable Lake-MacDowell Lake Fault Zone". No fault has been observed along the eastern boundary of the belt. The fault system in the western part of the map-area has imposed cataclastic textures on many rock types and has complicated interpretation of the stratigraphy of the metavolcanic-metasedimentary sequence in the southwestern part of the belt.

Within the North Spirit Lake Belt, the rocks have been folded and faulted.

The exact pattern of folding is at present unclear because of structural complexity and the low outcrop density in some parts of the map-area in such places as between the South Bay of North Spirit Lake and the western arm of Hewitt Lake and also to the south of the map-area. In addition to the regional fault structures in the western part of the map-area, several structural features of relatively large scale can, however, be outlined. These are indicated in Figure 13, and are: the Hewitt Lake Anticline; the South Bay Syncline; the Tahoe Lake Fold; and the strike-slip faults between Wokokotai and Makataiamik Lakes, namely the Wokokotai Lake Fault and the Roseberry River Fault. The fold structures in particular are complex (see section on "Folds"). Between the crest of the southeasterly-dipping Hewitt Lake Anticline and South Bay Syncline there are a number of folds with axial planes almost at right angles to those of the Hewitt Lake Anticline and South Bay Syncline.

With the exception of the area north of the western end of Hewitt Lake, bedding dips are steep. Foliation, schistosity, or gneissosity are present in the rocks throughout most of the map-area; an exception is in the area underlain by ultramafic rocks south of Wapisipi Lake. Small tension gash fractures several centimetres in length are common for example on the south shore of Hewitt Lake just west of the "V" in the lake. At this locality there are open elliptical fractures several centimetres long and less than an 2 cm wide. Some of these fractures are quartz filled such as those on an outcrop approximately 300 m northwest of Wokokotai Lake.

FOLDS

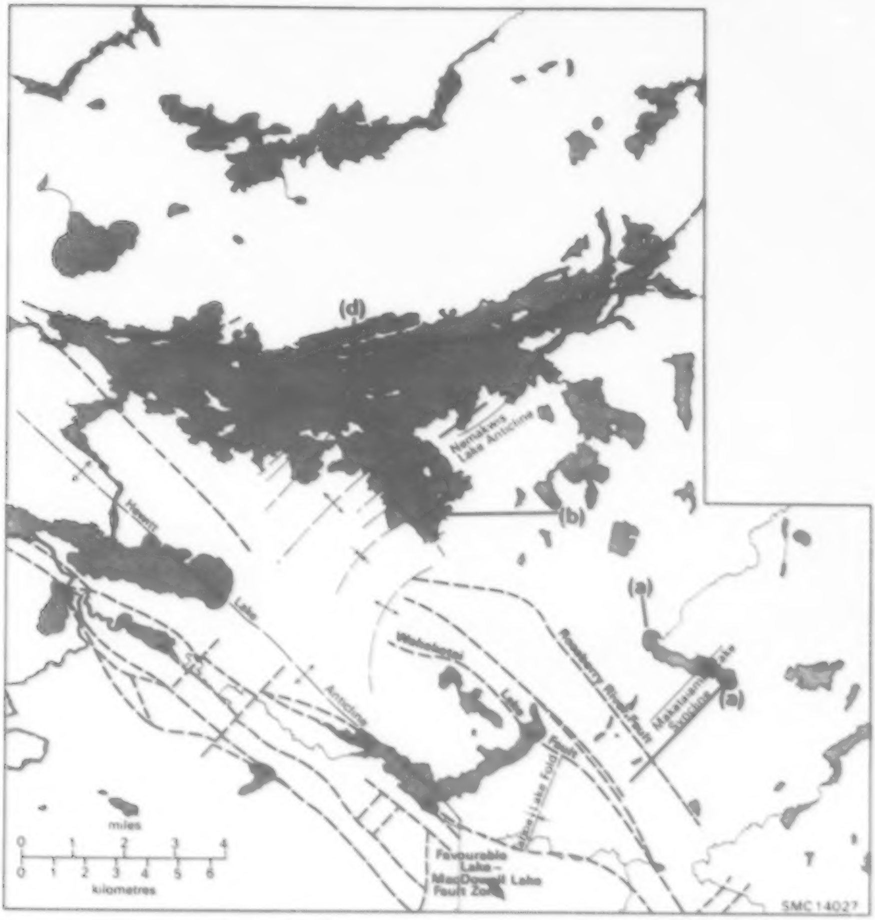
Fold structures within the map-area vary in size from those visible only under the microscope to those outlined only by field mapping. The collection of oriented samples during field studies was not possible, consequently only macroscopic folds will be discussed. Figure 13 illustrates the position of the trace of the axial plane of each of the large folds within the map-area.

NORTHWEST-STRIKING FOLDS

The two folds with a northwesterly axial strike are the largest within the field area. They are several kilometres across and their axial planes can be traced for several kilometres. The synclinal fold can be observed most clearly in the South Bay of North Spirit Lake, hence the name "South Bay Syncline". The anticline for analogous reasons is called the Hewitt Lake Anticline.

The placing of the axial trace of the Hewitt Lake Anticline is based on the following:

1) Observable deformation north of the western end of Hewitt Lake;
2) Stratigraphic top indicator directions in the same vicinity;
3) The spatial arrangement of rock units such as the carbonatized mafic metavolcanic unit;
4) The preservation of synclinal rafts of metavolcanics and metasedi-


(d)
Nemakwis Lake Anticline
(b)
(a)
Hewitt
Lake
Anticline
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(a)
Favourable Lake – MacDowell Lake Fault Zone
miles
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Figure 13–Major fault and fold structures of the North Spirit Lake and Hewitt Lake Areas. The lettered lines indicate the position of vertical sections illustrated in Figure 10.

ments between anticlinal areas underlain by granitic rocks on a regional scale (see Map 2262, Ayres *et al.* 1971).

The core of the anticline, the Margot Lake granitic body, broadens to the northwest and merges with the batholithic granitic rocks.

The shape of the fold is outlined by the carbonate-bearing mafic metavolcanic unit which outcrops intermittently from Little Hewitt Lake to the central part of Hewitt Lake. This unit outcrops along the southern shore of the eastern arm of Hewitt Lake as far east as the prominent point on the north shore of Hewitt Lake, and also outcrops on the north shore of the lake. With the exception of a few outcrops of carbonatized mafic metavolcanics approximately 1.5 kilometres east of the northern end of Wakokotai Lake, no further trace of this rock type has been found in the map-area. The fold is therefore shaped like a "U" with 90° corners. This is an unusual shape for a large-scale fold structure. The author considers that the present shape is a modification of an isoclinal fold where the eastern limb was dragged from the western limb to open up the original fold structure.

The South Bay Syncline is most evident in the area immediately to the north of the map-area (Wood 1977). It can be traced within the map-area for a short distance only, and is most clearly detected south of South Bay where the thin veneer of metasediments along the shore of the bay and the intermediate pyroclastic rocks further inland from the lakeshore can be traced around the south end of the bay. Top directions in the metasediments (Wood 1977) indicate that the fold is a syncline. The closure of the fold to the south indicates that the axis dips northwards, but no precise angle of dip for the axis was determined. In the area to the north of the map-area (Wood 1977) the fold is several km across and the trace of its axial plane can be outlined for more than 6 km.

South of South Bay, the form of this syncline is not clear. About 2 km southeast of South Bay, a fold structure is outlined by Iron Formation. This particular fold is open to the south. If it is the continuation of the South Bay Syncline, then the axial dip is to the south, and the axial plane of this fold is offset either by folding or faulting. This fold structure is truncated to the south by a fault. South of this fault there is no further evidence of a synclinal structure. The metasediments south of Makataiamik Lake indicate stratigraphic top directions towards the southwest. There are no stratigraphic indicators in the felsic to intermediate metavolcanics, but the author interprets them to lie stratigraphically above the metasediments. The stratigraphy is difficult to decipher near the eastern end of Hewitt Lake because of the northwest-striking faults.

A simple relationship cannot be established by the author between the South Bay Syncline and the Hewitt Lake Anticline within the the area bounded by South Bay, Wokokotai Lake, and Makataiamik Lake. Northeast of Margot Lake, the relationship is straightforward, all stratigraphic tops are to the northeast; the northeastern limb of the anticline is the southwestern limb of the syncline.

NORTHEAST-STRIKING FOLDS

There are three sets of northeast folds: the Tahoe Lake "Fold"; the folds south and west of South Bay; and the folds west of Nemakwis Lake, the Nemakwis Lake Anticline [out of the map-area], and near Makataiamik Lake, the Makataiamik Lake Syncline.

The Tahoe Lake "Fold" is bounded to the northeast and southwest by faults. The nature of the "fold" is not known because of the lack of stratigraphic top indicators. The "fold" could account for the difference in strike direction between the supracrustal rocks which outcrop on the south shore of the eastern part of Hewitt Lake and strike parallel to the length of the lake, approximately N45°E, and the strike direction of approximately N20°W in the supracrustal rocks northeast of Tahoe Lake (see Figure 13). The core area of the fold is poorly exposed and is covered largely by swamp, but south of the eastern end of Hewitt Lake, individual sediment beds that form a fold nose can be traced in the field.

Because of the lack of outcrop, it is difficult to place the fold in its regional setting. The fold could be the southern continuation of the South Bay Syncline. As noted before, there is no apparent southward continuation of the South Bay Syncline, and the fold cannot be traced in the zone of northwest-striking faults. Also, the eastern limb of the Hewitt Lake Anticline appears to have been rotated. This limb forms the northern limb of the Tahoe Lake "Fold". If this limb is rotated anticlockwise to a position compatable with the other limb of the Hewitt Lake Anticline, the effect of some of the northwest fault structures would be removed. Also the trace of the axial plane of the Tahoe Lake "Fold" would have a direction similar to the axial plane of the anticline and South Bay Syncline. The position of the Tahoe Lake "Fold" would then be to the east of the anticline where the projection of the South Bay Syncline would be expected.

Cross-folds relative to the South Bay Syncline have a northeasterly axial direction, and can be outlined from the vicinity of Pontoon Bay on North Spirit Lake (see Wood 1977) to Wokokotai Lake. They are most easily observed between Bijou Point [north of the map-area] and the southern end of South Bay. The scale of the most northwesterly folds is small, but those near South Bay are much larger; they have a crest to crest dimension in the order of 1.5 km and can be traced axially for several kilometres (see Wood 1977). The cross-folds appear to have a subhorizontal axial direction. There is no evidence that the cross-folds intercept the Hewitt Lake Anticline. The temporal relations of the two northwest- and northeast-striking fold generations are not known; the outcrop pattern would be similar regardless of the sequence of folding.

The anticlinal structure west of Nemakwis Lake (Wood 1977) and the synclinal structure near Makataiamik Lake are older than any other fold structures in the map-area, and have vertical or steeply dipping axes. During deposition of the sedimentary sequence near Makataiamik Lake the depositional basin underwent continuing subsidence, and formed a synclinal structure. West of Nemakwis Lake, there was a positive area or anticline. Thus, within the Makataiamik Lake sedimentary sequence, there are conglomerate outcrops composed primarily of ultramafic detritus derived from underlying flows exposed in the anticlinal area to the north, and there are chromium-rich micas derived from the breakdown of the chrome-bearing ultramafic rocks.

DRAG AND PARASITIC FOLDS

Drag folds are uncommon within the map-area. Where indicated on the map, (Map 2408, back pocket) they may be either drag folds associated with a fault zone or parasitic folds on the limbs of a larger fold. In general, where a drag fold is vertical or steeply dipping, the fold is associated with a fault structure rather than a fold structure.

INTERFERENCE FOLDS

Interference fold patterns on a small scale, in contrast to the large-scale fold patterns around South Bay, were observed in metasediments just west of the southern end of Wokokotai Lake.

JOINTING

Jointing, although extensively developed in the granitic rocks, is recorded on the accompanying map (Map 2408, back pocket) only where joints are very well developed, thereby suggesting a relationship with tensional fractures. In the western part of the map-area, the predominant direction of jointing (see Map 2408, back pocket) is approximately at right angles to the northwest-striking fault zone.

GNEISSOSITY

Gneissosity in rocks of the map-area has originated either as a consequence of shearing, gneisses of this origin are commonly found in the northwest-striking fault zone in the western part of the map-area; or, very high grade dynamothermal metamorphism that is restricted to local occurrences in the metasediments in the vicinity of Margot Lake. The fault-related gneisses are very fine grained, whereas the dynamothermal gneisses are coarse grained.

FAULTS

There are two directions of faulting within the map-area, they are northeast and northwest (see Figure 13). Northwest-striking faults are primarily strike slip faults. As a result of their compressional character, fault zones are characterized by extensive shearing and mylonitization. The northeast-striking faults are primarily tensional fractures. Thus there are no well-developed crushed zones. Joint structures, particularly in the metavolcanics and metasediments, have a similar orientation to the faults which otherwise can be traced only by separation of strata. The lack of definitive evidence regarding the relative age of the fault sets, the movement directions, particularly of the northwest faults, are a function of low outcrop density. The northwest faults on which movement direction can be recognized have a right-handed strike movement, for instance, the Roseberry River Fault.

The most obvious period of fault movement has occurred after consolidation of the granitic rocks. Serious consideration, however, should be given to the possibility that at least some of the faults were active during folding.

The Favourable Lake-MacDowell Lake Fault Zone consists of at least six northwest faults; the number identified would undoubtedly be higher if the outcrop density was greater. This fault zone forms part of a regional fault system extending from beyond Favourable Lake to the northeast to beyond MacDowell Lake to the south (see Ayres *et al.* 1972)which forms a sub-province boundary within the Superior Province of the Canadian Shield (see Ayres *et al.* 1970). To the northeast of the fault zone, lies the Gods Lake Subprovince, and to the southwest, the Berens River Subprovince (Ayres *et al.* 1970). Ayres (1971) considers that the overall downdrop is to the north. Within the map-area, the overall direction of downdrop is to the northeast judging from the preservation of the metavolcanic-metasedimentary rocks to the northeast of the fault zone; individual faults may have differing senses of movement.

The Roseberry River Fault separates the sequence of met[illegible]ents near Makataiamik Lake from the overlying metavolcanic sequence. [illegible] most obvious fault movement occurred after intrusion of the mafic sills into the metasediments and before the intrusion of the granitic rocks. From field work done during 1975, the mafic intrusions on either side of the fault are co-magmatic and the mafic metavolcanics at the southern boundary of the map-area are the same as those at Makataiamik Lake. The fault therefore has an apparent right-lateral horizontal component of displacement of more than 3.2 km. West of the fault, [illegible] metamorphic assemblages in metasediments observed during field work in 1975 indicate a higher grade than those to the east of the fault. It is concluded by the author that the downthrow side is to the east.

Near the eastern end of Hewitt Lake, several faults particularly the Wokokotai Lake Fault (Figure 13) parallel the Roseberry River Fault. These faults complicate fold structure interpretation by having terminated fold structures. The Tahoe Lake "Fold" and perhaps the northeastern limb of the Hewitt Lake Anticline are terminated by faults.

The diabase dike in the northwestern part of the map-area is apparently little affected by any of the major fault structures, and is therefore younger than them. One of the remaining fault problems is the determination of the original altitude of the fault surface. Consideration should be given to the possibility that some of the steeply dipping faults have been originally sub-horizontal.

ECONOMIC GEOLOGY

Indications of chromium, cobalt, copper, gold, iron, nickel, lead, and zinc mineralization have been found within the map-area. There are no known economic mineral deposits in the map-area to date. Recent mineral exploration has not been restricted to finding any one specific commodity such as gold which was the prime target in the early days of exploration of the map-area and the adjoining region (Bateman 1938). A brief history of known exploration within the map-area was given on in the section on "Previous Geological Work and Prospecting Activity".

This section of the report is divided into two parts, that titled "Mineralization" is intended to set in perspective the type of mineralization within the map-area; the part of the report entitled "Properties and Occurrences" provides information on individual mineral deposits and explored ground. Numbers in parentheses after Property and Occurrence names refer to property locations on Map 2408, back pocket and Figure 14.

Mineralization

Thirty two grab samples of rocks from the map-area, collected by the author and his assistants were spectrographically analyzed by the Geoscience Laboratories, Ontario Geological Survey, contained traces of chromium, cobalt,copper, lead and nickel (Tables 7 and 8) In addition to some of these metals zinc is reported from two localities in drill-logs (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake). All of the analyzed samples showed sulphide mineralization on outcrop. On the basis of the samples examined by the author there is a distinct chromium-copper-nickel association in mineralized rocks within the map-area. This association occurs in metasediments and metavolcanics (Tables 7 and 8). The two highest assay values (samples W-73-48 and W-73-51; Table 7) were obtained from metasediments.

MINERALIZATION IN METASEDIMENTS

Mineralized metasediments can be broadly divided into three groups: conglomerate; sandstone; and chemical metasediments.

Conglomerate

There are two occurrences of mineralized conglomerate; one is just to the south of the western end of Makataiamik Lake , and the other is approximately 2100 m west-northwest of the western end of Makataiamik Lake. Descriptions of the rock types at the two occurrences are given in the section "Conglomerate" earlier in the report.

The conglomerate at the western end of Makataiamik Lake contains minor, less than 1.0 percent, mineralization which is disseminated, in thin veinlets, and consists primarily of pyrite and subordinate amounts of pyrrhotite. Logs of a hole diamond drilled by Noranda Exploration Company Limited in 1969 indicate traces of gold and silver over a core length of 6 m, with low values of copper and nickel over the same length. Values occur of 0.27 percent copper and 0.08 percent nickel over a length of 0.76 m, and 0.25 percent copper and 0.09 percent nickel over a length of 0.76 m (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake).

Mineralization in the conglomerate 2100 m west of Makataiamik Lake (Table 7, sample W73.48) consists of magnetite, chalcopyrite, azurite, and malachite, and occurs in small (less than 1 cm in diameter) clots in the rock matrix. The occurrences have been trenched, but no data exists in the Resident

TABLE 7 SPECTROGRAPHIC ANALYSES OF METASEDIMENTS IN THE HEWITT LAKE AREA, ANALYSES BY GEOSCIENCE LABORATORIES, ONTARIO GEOLOGICAL SURVEY.

Sample Number	Chromium	Copper	Nickel	Lead	Vanadium	Rock Type
W-72-15	0.06	—	0.01	—	—	Sdst.
W-72-16	0.06	—	—	—	—	Sdst.
W-72-21	0.06	0.01	0.01	—	T	Chert
W-72-23	0.05	0.01	0.01	—	T	Chert
W-72-42	0.06	0.01	—	—	T	MV? Chert?
W-72-53	0.06	0.01	—	—	—	Chert
W-72-73	0.06	0.03	—	—	—	Chert
R-72-15	0.02	0.01	0.04	0.01	T	Sdst.
R-72-45	0.01	0.02	—	—	T	Chert
R-72-81	0.01	0.01	0.02	0.01	T	Sdst.
R-72-120	0.01	0.05	0.04	—	T	Sdst.
R-72-135	0.01	0.01	0.02	—	T	Chert
R-72-187	0.01	0.02	0.03	—	—	Sdst.
W-73-48	0.01	0.95	0.08	—	T	Congl.
W-73-50	0.01	0.02	0.01	0.03	—	Sdst.
W-73-51	0.01	0.02	0.01	0.40	—	Sdst.
H-73-120	0.01	0.01	0.04	—	T	Sdst.
H-73-124	0.01	—	0.01	0.03	T	Chert

Notes:
Results are given in percent

Abbreviations:
Sdst. - Sandstone
MV? - Mafic volcanic
Congl. - Conglomerate
T - Trace amounts detected
— - None detected

Geologist's Files at Red Lake about the results of the trenching. A grab-sample collected by the author from one of the more highly-mineralized parts of the occurrence and analyzed by the Geoscience Laboratories, Ontario Geological Survey, gave 0.95 percent copper, 0.08 percent nickel, and trace amounts of chromium and vanadium. Because of the inhomogeneity of the rock-type, a trench sample would be necessary to obtain representative results. The occurrence was diamond drilled by Madsen Red Lake Gold Mines Limited in 1970. Logs of three diamond-drill holes totalling 108.5 m in length indicate "streaks", "blebs", and "specks" of pyrite, chalcopyrite, pyrrhotite, and arsenopyrite, but no assay results were given.

TABLE 8 SPECTROGRAPHIC ANALYSES OF IGNEOUS ROCKS, ANALYSES BY GEOSCIENCE LABORATORIES, ONTARIO GEOLOGICAL SURVEY.

Sample Number	Chromium	Copper	Nickel	Lead	Vanadium	Rock Type
W-72-2	0.01	—	—	—	T	IV
W-72-37	0.06	0.03	0.01	—	T	MV
W-72-38	0.06	0.03	0.02	—	T	MV
W-72-39	0.06	0.03	0.02	0.01	T	MV
R-72-78	0.01	—	0.02	0.01	T	I-MV
R-72-80	0.01	0.02	0.02	0.01	T	F-IV
R-72-84	0.01	—	0.02	—	—	QV
H-73-117	0.01	0.01	0.01	0.02	T	F-IV
H-73-118	0.01	0.02	0.01	0.01	T	F-IV
H-73-123	0.01	0.02	0.01	—	T	F-IV
W-73-43	0.01	0.03	0.03	—	T	MV
W-73-43A	0.01	0.05	0.03	—	—	MV
W-73-44	0.01	0.02	—	—	—	Dike

Notes:
Results are given in percent

Abbreviations:
T - Trace amounts
IV - Intermediate metavolcanics
MV - Mafic metavolcanics
I-MV - Intermediate to Mafic metavolcanics
QV - Quartz Vein
F-IV - Felsic to Intermediate metavolcanics

Sandstone

Ten occurrences of chromium, cobalt, copper, lead, nickel, and zinc mineralization were located in sandstone during the field-mapping. Three have been explored by mining companies and individuals, and are described individually; the others are described in groups based on lithology.

Just north of the western end of Hewitt Lake, a unit of subarkose contains about 1 percent (visual estimation) disseminated fine-grained pyrite with some chalcopyrite. Two samples (Table 7, W-72-15 and 16), collected by the author and spectrographically analyzed by the Geoscience Laboratories, Ontario Geological Survey, contain approximately 0.06 percent chromium, 0.01 percent nickel; and 0.06 percent chromium respectively. Based on existing data, the potential of this occurrence appears to be limited.

Lithic arkosic wacke and lithic subarkosic wacke host sulphide mineralization in four localities. At the first locality, 4.8 km north of the western part of Hewitt Lake, the rock outcrop is rusty weathering and medium bedded, with minor disseminated pyrite and chalcopyrite. About 0.03 percent cobalt was obtained in addition to traces of chromium, copper, nickel, and vanadium (Table 7) from a grab sample (R-72-120) spectrographically analyzed by the Geoscience Laboratories, Ontario Geological Survey.

A sample of rusty weathering lithic subarkosic wacke (R-72-187) collected from an outcrop about 1.5 km east of the eastern end of Little Hewitt Lake contains low values (Table 7) of chromium, copper, and nickel. The rusty outcrop is a consequence of the oxidation of disseminated pyrite. The potential of this occurrence as exposed, is low.

Approximately 1.5 km south-southwest of the prominent peninsula near the western end of Hewitt Lake, a lithic subarkosic wacke, with a green-grey colouration (due to chloritic minerals) contains small amounts of disseminated fine grained sulphide mineralization. A sample, R-72-81 (Table 7), collected by the field party and spectrographically analyzed by the Geoscience Laboratories, Ontario Geological Survey, contained small amounts of chromium, copper, nickel, and lead. The potential of this occurrence is not known, there are shear zones and mylonitic zones in adjacent outcrops, which are also mineralized, (see section on "Felsic to Intermediate Metavolcanics") and the outcrop from which the sample was taken is schistose and contains quartz veins 2 to 10 cm thick.

Just to the east of the small lake south of Wokokotai Lake, there is an occurrence of immature metasediments; the sandstone member, a feldspathic lithwacke, contains disseminated sulphide mineralization. Pyrite was recognized on outcrop, and a grab-sample, R-72-15 (Table 7), collected by a field party member and spectrographically analyzed by the Geoscience Laboratories, Ontario Geological Survey, contained traces of chromium, copper, nickel, and lead.

A sulphide-stained outcrop of quartz arenite some 2.4 km west-northwest of Makataiamik Lake contains disseminated pyrite with minor amount of chalcopyrite and pyrrhotite. A grab sample (H-73-120, Table 7) collected by field party personnel and spectrographically analyzed by the Geoscience Laboratories, Ontario Geological Survey, contains small amounts of chromium, copper, and nickel. The outcrop area contains two easterly-trending trenches, one about 3 m long, and about 0.6 m wide, the other about 7.6 m long and about 1.5 m wide. It is not known who did the trenching or the results of the trenching. Logs of a 30 m long diamond-drill hole drilled by Madsen Red Lake Gold Mines Limited in 1970 (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake) indicate that disseminated specks of chalcopyrite, and traces of arsenopyrite are present in addition to pyrite and pyrrhotite. Four sulphide veins up to 10 cm thick were encountered between 7.6 and 19 m. No assay work was recorded.

Chromium, copper, lead, and nickel mineralization occurs 2100 m south of the western end of Makataiamik Lake in arsenopyrite-fuchsite-tourmaline veins and is disseminated in medium- to thickly-bedded lithic arkosic wacke, lithic subarkosic wacke, and subordinate granule and pebble conglomerate. The largest vein visible, trends at approximately 20° east of north, is 15 m long by 1.2 m wide, and dips steeply. The vein has been extensively blasted so that no original features can be observed. Another vein is approximately 0.3 m thick with a strike of N100°E east which is parallel to the strike of the metasediments, and has an exposed length, in a blast pit, of 1.8 m. There are several small veins, in the order of 2.5 cm wide, which have no preferred orientation. Although no potentially economic mineralization was noted in samples blasted from the large vein, the more highly mineralized of two blasted samples (W-73-50 and W-73-51; Table 7) on analysis by the Geoscience Laboratories, Ontario Geological Survey, contains approximately 0.01 percent chromium, 0.02 percent copper, 0.40 percent lead, 0.01 percent nickel, and 0.05 ounce of gold per ton with traces of antimony.

Mineralization in the associated metasediments is disseminated, patchy, and small in amount. Galena, observed on outcrop, occurs in small but readily identifiable crystals. Several small pits, at least four in number, and less than 1.8 m in diameter have been blasted; it is not known who blasted the pits or at what time the blasting was done. Localized shearing at N130°E was noted in one of the pits. Scurry-Rainbow Oil Limited in 1968 diamond drilled two holes totalling 19.8 m in length. Minor pyrite, pyrrhotite, galena, arsenopyrite, and sphalerite were noted in the diamond drill logs. Assays of base metals were made by Scurry-Rainbow Oil Limited and are given in ounces per ton. A narrow muscovite-garnet-pegmatite dike was noted in the same vicinity as the mineralization, but no relationship between the mineral veins, the mineralized metasediments, or the pegmatite dike was apparent. Based on available data, the potential of this occurrence is limited. The sulphides in the metasediments are not evenly distributed so that proving tonnages of economic minerals would be difficult. The veins may offer somewhat more potential, for the larger ones at least should be traceable by ground geophysical techniques.

The McDonald Occurrence (10), is 360 m west of the pear-shaped lake 4 km south of Makataiamik Lake and contains copper, gold, lead, zinc, and silver mineralization. Host rocks to the mineralization are: mylonitized metasediments which include a black fine-grained argillite possibly originally a black shale or para-amphibolite; and siliceous metasediments of uncertain origin, possibly sheared sandstone, or siliceous iron formation. The metasediments occur adjacent to the contact with a diorite sill. The shear-zone has a northwesterly trend and is indicated on the accompanying map, Map 2408, back pocket, and on Figure 13 as the Roseberry River Fault. The shearing observed on outcrop may represent only a part of the shear-zone; outcrop density is insufficient for precise delineation of the fault. The metasediments exposed have been extensively blasted, (who did the blasting and at what time are not known). Three pits occupy most of the outcrop area. Fine-grained pyrrhotite,pyrite, sphalerite, and galena, which occur in small pods and veinlets, were identified at the outcrop by the author.

Drill logs of three diamond-drill holes totalling 88.3 m in length, diamond-drilled on the occurrence in 1957, indicate that pyrite was found in the diamond-drill core and that traces of copper and nickel were found by assay (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake). Drill core-logs of three short holes totalling 156.8 m in length drilled in 1968 indicate bedrock to be "gabbro" and "metavolcanics" and pyrrhotite, pyrite, arsenopyrite, sphalerite, galena, and chalcopyrite, to be present in the rocks (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake). Assay results quoted in the diamond-drill logs indicate a high silver content as follows: 3.72 ounces of silver per ton and 0.01 ounce of gold per ton over a length of

0.6 m; 1.94 ounces of silver per ton and 0.02 ounce of gold per ton over a length of 0.4 m; and also indicate the presence of copper, lead, and zinc.

In 1969, two diamond-drill holes totalling 157.6 m in length were drilled on the occurrence. One hole was abandoned at 43.9 m because of bad ground. Logs of the diamond-drill holes indicate that rock-types underlying the outcrop area are predominantly argillite, amphibolite, argillite-quartzite, argillite-conglomerate, and banded magnetite iron formation. Patches of pyrite, galena, and sphalerite, were also noted in the drill-logs. A 1.5 m length of drill core was reported to have yielded an assay of 0.90 ounce per ton of silver (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake).

Airborne electromagnetic data from a survey made in 1969 by Questor International for Noranda Exploration Company Limited, kept in the Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake, indicates a six channel anomaly close to or on the site of the occurrence with another anomaly close by. Further mineralization could be found in the vicinity of this occurrence.

Chemical Metasediments

All the mineral occurrences in chemical metasediments are located in rocks which may be described as Iron Formation. The rocks at all the mineral localities examined by a member of the field party consist of layers of recrystallized chert alternating with layers of magnetite and sulphide minerals (principally pyrite and/or pyrrhotite). The thickness of the layers varies within any one occurrence. The minimum thickness observed during field work was in the order of several millimetres, and the maximum thickness observed was several centimetres. The proportion of sulphide to oxide in the metallic layers is also variable. During field work, due to poor outcrop control, it was not possible to follow any one horizon of cherty rock due to low outcrop density to investigate whether there was a variation across strike at any given locality, or a variation along strike between localities. The impression gained by the author suggests that there is a variation in the sulphide/oxide proportion of some rock units along strike. The unit that extends from the northwestern part of Wokokotai Lake south and west towards the central part of Hewitt Lake is predominantly oxide rich in the north, and sulphide rich along the northern shore of Hewitt Lake.

Three of the samples collected by the field party and spectrographically analyzed by the Geoscience Laboratories, Ontario Geological Survey, came from the Wokokotai Lake-Hewitt Lake unit (Map 2408, back pocket). Two samples (W-72-21 and W-72-23, Table 7) were grab-samples taken from outcrops on the Chimo Occurrence (1). One sample (R-72-135, Table 7) was collected from an outcrop on the western shore of Wokokotai Lake. None of the analyzed samples show high values of any metal. The principal sulphides observed on outcrop are pyrite and pyrrhotite with only sparse, occasional specks of chalcopyrite. The exploration work of Chimo Gold Mines Limited in 1963 included pitting, trenching, and diamond-drilling. Rare grains of chalcopyrite were noted in diamond-drill core logs, however, no assays of base metals or gold were given (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake).

A grab sample, R-72-45, Table 7, of sulphide-bearing cherty rock collected by a field party member from an outcrop on the southern side of the western part of Hewitt Lake and spectrographically analyzed by the Geoscience Laboratories, Ontario Geological Survey, contained small amounts of chromium, copper, and vanadium.

A grab sample, W-77-53, Table 7, of a pyritiferous siliceous rock collected by the author from a rusty weathering outcrop on the southern side of Hewitt Creek about one-third of the way from Hewitt Lake to Little Hewitt Lake, contained small amounts of chromium and copper which were revealed by spectrographic analysis done by the Geoscience Laboratories, Ontario Geological Survey. The rock is extensively sheared, and pyrite occurs in thin 1 to 2 mm laminae parallel to the shear planes. Deformation has been sufficiently intense that no original textures were preserved. It is therefore difficult to determine the original nature of the rock. Its siliceous character suggests, however, that probably a chert-sulphide chemical sediment, or perhaps a felsic metavolcanic were its progenitors. The potential for further mineralization in this locality is not known.

Chert with magnetite and fine-grained disseminated pyrite (2 to 3 percent) occurs as sedimentary interbeds in a pillowed mafic metavolanic sequence 0.8 km south of Little Hewitt Lake.

Although some typical iron-formation layering is present in the cherty rocks, the divisions between chert layers and metallic mineral layers is indistinct. The sulphides occur disseminated in the chert layers and the magnetite-rich layers. Values of chromium and copper in a grab sample collected by the author and analyzed by the Geoscience Laboratories, Ontario Geological Survey, are low. The metasediments form a minor component of the exposure.

Approximately 2400 m south of the western end of Makataiamik Lake, immediately to the south of a small triangular lake, there is an outcrop of very finely interbedded chert, magnetite, and black shale with minor amounts of sulphides finely disseminated throughout the rock. A grab sample (H-73-124) collected by a field party member and spectrographically analyzed by the Geoscience Laboratories, Ontario Geological Survey contained small amounts of copper, nickel, lead, and vanadium.

A zone of rusty, sheared, dark coloured, friable rock occurs 1200 m west of the western end of Hewitt Lake and is as much as 30 m thick in places and contains three pits. The pits are of ill-defined shape, but have a maximum diameter of about 2.7 m and a depth of about 1.8 m. There is no record of when or by whom the pits were made, but it may be assumed that they are relatively old since the walls of the pits are thoroughly weathered. Despite the added exposure provided by the pits, it was not clear during field mapping whether the mineralization was in sheared mafic metavolcanics or sheared sulphide facies iron formation.

Mineralization consists primarily of disseminated pyrite, up to approximately 20 percent by visual estimation, with minor chalcopyrite. About 0.02 percent cobalt in addition to chromium, copper, and vanadium, was determined from the spectrographic analysis of a sample (sample W-72-42; Table 7) collected by the author and analyzed by the Geoscience Laboratories, Ontario Geological Survey.

MINERALIZATION IN IGNEOUS ROCKS

Most of the sulphide minerals found in igneous rocks occur in metamorphosed volcanic rocks, two occurrences in granitic rocks, and one in a quartz vein.

Mafic to Intermediate Metavolcanics

Mafic to intermediate metavolcanics host sulphide minerals in two localities. On Hewitt Lake, approximately 0.4 km east of the "V" on the southern shore of the lake, there are fine-grained macroscopically unidentifiable sulphide minerals in mafic metavolcanics which possibly have ultramafic affinities. Some of the sulphides are finely disseminated in the rock, others occur in thin stringers along shear planes. Three samples (W-72-37, W-72-38, W-72-39; Table 8) collected by the author and spectrographically analyzed by the Geoscience Laboratories, Ontario Geological Survey, yielded low values of chromium, copper, nickel, and traces of vanadium. One sample yielded a low lead value, another a low value of cobalt (0.01 percent). No higher grade mineral showings were enountered in this locality, and the economic potential of the occurrence is probably low.

Sulphide minerals occur also near the western end of Makataiamik Lake in the trenched shear zone at the contact of mafic metavolcanics and conglomerate on the Noranda Exploration Company Limited, Desmeules Occurrence (12). The mineralization which includes pyrite, magnetite, chalcopyrite, and arsenopyrite, occurs in veins localized by shearing parallel to the contact.

It is not known who trenched the outcrop. In 1968, Scurry Rainbow Oil Limited, Mining Division drilled three diamond-drill holes totalling 58.2 m in length just to the south of the trench. All three diamond-drill holes were located in metasediments; disseminated and semi-massive pyrrhotite, pyrite, and chalcopyrite were noted in diamond-drill logs (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake).

In 1969, Noranda Exploration Company Limited drilled a north-dipping (56°) hole, 105.8 m long and collared about 60 m south of the showing. Diamond-drill logs (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake) indicate that the drill hole passed through the metasedimentary-metavolcanic contact where pyrrhotite, pyrite, and chalcopyrite were encountered. Two samples (W-73-43, W-73-43A; Table 8) collected by the author and spectrographically analyzed by the Geoscience Laboratories, Ontario Geological Survey contain low values of chromium, copper, and nickel, one contains traces of vanadium, the other 0.15 percent cobalt by assay. The results of past exploration work, such as an airborne electromagnetic survey in 1969 by Questor for Noranda Exploration Company Limited (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake), indicate a number of electromagnetic anomalies along strike from the occurrence.This and the geological setting in a shear zone; indicate potential for higher grade more extensive mineralization in the general vicinity of the showing.

Felsic to Intermediate Metavolcanics

About 1280 m south-southwest of the prominent peninsula in the western part of Hewitt Lake, a grab sample (R-72-78, Table 8) of brecciated rock was collected from a small outcrop by a field party member and was analyzed by the Geoscience Laboratories, Ontario Geological Survey. The sample gave low values of chromium, lead, and nickel with traces of vanadium. The sulphides are fine grained, disseminated- and in small clusters several millimetres in diameter. The rock outcrop is extensively sheared; the precise origin of the rock-type is unknown. Approximately 30 m to the south of the outcrop from which sample R-72-78 (Table 8) was collected, an outcrop of less strongly sheared felsic to intermediate tuff and lapilli-tuff extends for about 0.4 km along strike to the southeast. Pyrite is finely disseminated in the felsic to intermediate metavolcanics of this outcrop, and it is suggested that the rock-type represented by sample R-72-78, Table 8, may be a highly sheared equivalent. A grab sample (R-72-80; Table 8) collected by a field party member from the larger outcrop and spectrographically analyzed by the Geoscience Laboratories, Ontario Geological Survey, contained low amounts of chromium, copper, nickel, lead and vanadium. A considerable amount of further work would be required to assess the potential of these occurrences.

The discontinuous sequence of felsic to intermediate metavolcanic, pyroclastic, and flow rocks that extends from the South Bay of North Spirit Lake to northwest of the northwest-flowing part of the Roseberry River System contains disseminated sulphides at several localities. Sulphide minerals are predominantly pyrite and pyrrhotite, but occasional grains of chalcopyrite, galena, or sphalerite were encountered. Grain size is uniformly small, and observed amounts of sulphides seldom constitute more than 2 to 3 percent of a rock. A grab sample (Samples H-73-123; Table 8) collected by a field party member from an outcrop about 2400 m east of Hewitt Lake contains small amounts of chromium, copper, nickel, and vanadium. Two samples (samples H-73-117, H-73-118; Table 8) were collected by the field party from two outcrops about 300 m apart on either side of the upper reaches of the stream flowing eastwards into Makataiamik Lake. These samples after spectrographic analysis by the Geoscience Laboratories, Ontario Geological Survey, revealed small amounts of chromium, copper, lead, nickel, and vanadium (Table 8). Further exploration work would be required to assess the economic potential of this sequence of metavolcanics.

Subvolcanic and Granitic Rocks

A grab sample, (Sample W-72-2; Table 8) from an outcrop located approximately 1.5 km west of the prominent peninsula in the eastern part of Hewitt

Lake) consists of medium- to fine-grained intermediate metavolcanic or metaintrusive rock, and after spectrographic analysis by the Geoscience Laboratories, Ontario Geological Survey, revealed traces of chromium, and vanadium. The sulphide minerals which constitute about 1 percent of the rock by visual estimation, are very fine grained and macroscopically unidentifiable. The economic potential of this occurrence as observed in the field is probably not great; however, the other parts of the unit in which the sulphides occur could host more concentrated mineralization.

Fine-grained disseminated pyrite (about 1 percent) was observed in the metamorphosed stock-like intrusion near the western end of Makataiamik Lake. A medium-grained sulphide-bearing sill considered by the author to be an offshoot of the body because of petrographic similarity, when sampled (Sample W-73-44, Table 8) by the author and after spectrographical analysis by the Geoscience Laboratories, Ontario Geological Survey, revealed small amounts of chromium and copper.

Just to the northeast of the pear-shaped lake some 4 km (2½ miles) south of the eastern end of Makataiamik Lake, molybdenite, disseminated in coarse flakes, and fine grained in narrow (1 mm) fractures, occurs in the granitic rocks. Magnetite is present disseminated and in stringers and together with the molybdenite form up to 3 or 4 percent of the rock. A grab sample collected by the author and analyzed by the Geoscience Laboratories, Ontario Geological Survey contained 0.01 percent copper and 0.03 percent molybdenum. Detailed geological mapping could delineate the extent of the mineralization at surface.

Quartz Vein

A grab sample (R-72-84, Table 8) of a 1.8 m wide, southeast-striking quartz vein was collected by the field party from an outcrop of sheared feldspathic sandstone some 1500 m north of the western end of Nipa Lake. After spectrographic analysis by the Geoscience Laboratories, Ontario Geological Survey, the sample revealed traces of chromium, nickel, and less than 0.005 ounce of gold per ton. The fine-grained sulphide mineral visible in the sample is probably pyrite. The outcrop area contains several quartz veins, in the size range 5 to 30 cm. All the veins strike at S30°E and dip at 70° north, parallel to the shearing trend in the host rock.

DESCRIPTIONS OF PROPERTIES AND OCCURRENCES

The history of mineral exploration within the map-area is pertinent to December 31, 1973, and is limited to data available from reports available to the public and that collected by the field party. The western half of the map-area, mapped during the summer of 1972, does not contain any explored parcels of land with the exception of parts of claim groups previously owned by Chimo Gold Mines Limited and Noranda Exploration Company Limited. The summer of 1973 was notable for extremely inclement weather, as a consequence, parts of the granitic terrane in the eastern half of the map-area were not mapped, and properties or occurrences in the eastern half of the map-area were not studied in detail. As of December 31, 1973, the only claims in good standing were the 14 patented claims east of the South Bay of North Spirit Lake (Crown Trust Company Limited), and four claims (Cochenour Willans Gold Mines Limited) extending south from the eastern end of Makataiamik Lake. Figure 14 illustrates the claim groups held by the various individuals or companies who have explored the map-area.

Chimo Occurrence (1)[1]

In 1963 Chimo Gold Mines Limited held a group of 24 claims centred approximately at the midpoint of the north shore of Hewitt Lake. Exploration consisted of some eight pits, one trench, and four diamond-drill holes totalling 252.7 m in length (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake). Rock exposure in the part of the map-area covered by this claim group is poor; about half of the claims extended over Hewitt Lake, most of the others were north of the lake where bedrock is almost totally hidden by Pleistocene sands and silts, and Recent swamps. Outcrops (Map 2408, back pocket) suggest that the geology underlying the claim group is probably complex. A fold axis (see Figure 13) passes through the rock underlying the claim group.

Exploration interest centred on the banded quartz (recrystallized chert) sulphide rock unit, the so called sulphide facies iron formation, presumably with a view to discovering gold mineralization. Of the exploration pits still recognizeable, some are in a carbonate unit which occurs in association with the chert unit in this part of the map-area. Diamond-drill hole data (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake) indicates the following: there may be several horizons of carbonate and chert; the carbonate is interbedded with the chert; and sulphides are present in the carbonate unit as well as in the chert unit. Thicknesses of the chert layers vary from a few millimetres to several centimetres. The sulphides, mainly pyrite and pyrrhotite, constitute up to 75 percent of the layers in which they occur; the remainder of a layer being composed of chert or in some instances chert and carbonate (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake). Rare grains of sphalerite and chalcopyrite are reported to be present in the diamond-drill core (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake), minute grains of chalcopyrite were identified by the author in diamond-drill core samples left at the diamond-drill sites.

In 1969, Noranda Exploration Company Limited held 15 claims which partly overlapped the claim group of Chimo Gold Mines Limited. Airborne magnetic and electromagnetic and ground magnetic and electromagnetic surveys were performed, but no further work undertaken (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake).

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[1] Number refers to property number on Map 2408, back pocket and Figure 14.

Cochenour Willans Gold Mines Limited (2)

In 1969, Cochenour Willans Gold Mines Limited optioned 24 claims located just to the south of the central and eastern parts of Makataiamik Lake. A ground electromagnetic survey was subsequently conducted on the claim group as part of the base-metal exploration programme of Cochenour Willans Gold Mines Limited (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake). No anomalous zones of conductivity were outlined. The geology of the claim group can be seen from Map 2408, back pocket. A small shallow test pit, about 1.5 m across, several centimetres deep and indicated on Map 2408, back pocket, has been blasted in a 1.2 m to 2.4 m thick albitic pegmatite dike which cuts the mafic intrusive rocks at the locality indicated. This dike is reported to contain minor amounts of chalcopyrite, pyrrhotite, pyrite, sphalerite, and molybdenite (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake). Pyrite and molybdenite were identified by the author in what remained of the rocks in the test-pit. Along strike, some 520 m to the northwest, minor pyrite in disseminated form was found in gabbroic rocks during the course of field-mapping.

Crown Trust Company Limited (3)

The 14 patented claims in the northern part of the map-area are the southern extension of a much larger patented claim group belonging to the Crown Trust Company Limited (See Wood 1977).

The geology of the claim group is as outlined on Map 2408, back pocket. The primary interest of the Crown Trust Company Limited is banded quartz (recrystallized chert) - magnetite the iron formation which outcrops in the northern part of the the map-area, and extends northwestward to North Spirit Lake.

In 1959, a ground magnetometer and reconnaissance geological survey was made of the claims within the map-area, three zones of iron formation were outlined (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake). One zone lies just west of the eastern shoreline of the southwest arm of Wapisipi Lake, and ends just inside the map-area. The next zone extends from the central part of the same arm of the lake through the shoreline outcrop in the southwest corner of the lake to just south of the lake; the third zone parallels the second about 75 m to the southwest, and terminates some 600 m southeast of the southwestern end of Wapisipi Lake. Two diamond-drill holes were recommended to test the second and third zones, but there is no information in the Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake, to indicate whether these holes were drilled.

The rock types associated with the iron formation are ultramafic metavolcanics. Stratigraphic top directions interpreted from chilled and fractured flow tops in the volcanic flow rocks indicate top directions to the southwest. The three zones of iron formation may represent three separate units, rather than one unit folded into an anticline-syncline configuration. However, outcrop density is low so that this cannot be proven. The ultramafic rocks should be regarded as possible host rocks for copper-nickel mineralization (See Naldrett 1973).

No satisfactory estimate can be made of the tonnage and grade of the iron formation due to the sporadic surface outcrops and the limited exploration data available.

G. Desmeules [1969] (4)

G. Desmeules in 1969 staked six claims approximately centred on the peninsula on the eastern shore of the South Bay of North Spirit Lake. Data in the Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake, indicate that two trenches were excavated on the peninsula, the more northerly one oriented east-west, measured 2.4 m by 3.7 m by 0.76 m deep and is located on the map-boundary some 15 m from shore. The second trench is located centrally on the peninsula about 30 m from its end, and is oriented northeast-southwest; dimensions given are 8.9 m by 3 m by 1.5 m. Neither of these pits were seen by the author, and no details of the geology are given in the Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake. The trenches were probably excavated to test rock types similar to those in the Interlac Occurrence (6). The claims have since been allowed to lapse.

Hewitt Lake Occurrence (5)

The only data available for the exploration work carried out by this company is in Bateman (1938, p.77):

> Prospectors for the Mining Corporation of Canada Limited, staked a group of 12 claims in 1936 on the northeast shore of the northeast arm of Hewitt Lake, as the result of obtaining gold in pannings from an exposure of rusty schist. The occurrence consists of a siliceous shear zone in dragfolded garnetiferous sediments near a contact with greenstone. Trenching failed to disclose any persistence to the zone, which outcrops as a low rusty cliff, about 20 feet wide, at the lake shore, striking slightly south of east. Mineralization consists of disseminated pyrite with minor amounts of arsenopyrite and pyrrhotite in fine-grained, chert-like, siliceous material. Three grab samples are reported by the company to have given 0.29 ounce per ton, 0.81 ounce per ton, and 0.14 ounce per ton. Subsequent check sampling failed to yield more than 0.10 ounce per ton in 17 samples. A grab sample taken by the writer returned 0.07 ounce per ton.

The pits are now completely overgrown. The rock type at the locality of the pits is a ferruginous, pyritiferous meta-chert and contains minor amounts of magnetite and pyrite. Mafic metavolcanics outcrop along the shoreline to the east and black shale to the west.

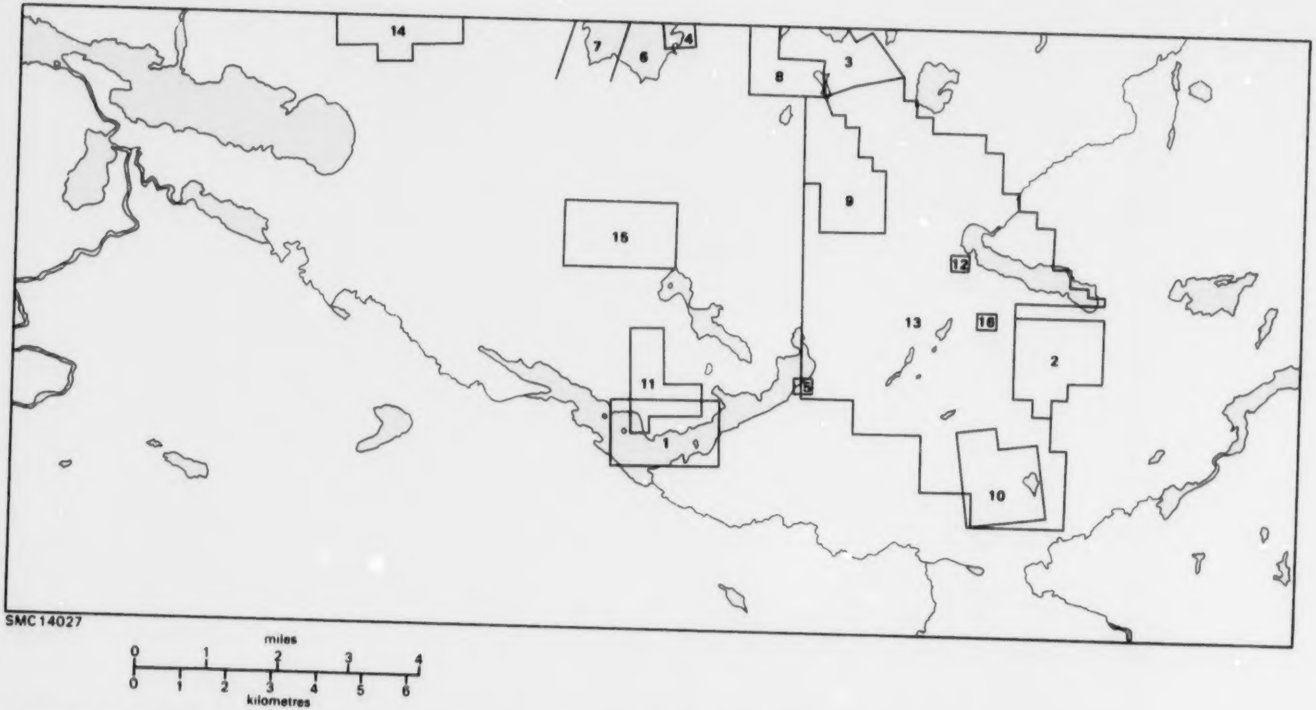
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Figure 14–Location of explored parcels of land in the Hewitt Lake Area. Numbers refer to property numbers given in legend, Map 2408, back pocket.

Interlac Occurrence (6)

Bateman (1938) reported that Interlac Gold Limited held a group of claims at the southeast end of South Bay. The claims were located near the northern boundary of the map-area. Bateman stated (1938, p.77):

> Mineralization consists of massive and disseminated arsenopyrite with small amounts of pyrite and chalcopyrite associated with actinolite. Two shallow test pits have opened up the discovery for an east-west length of 20 feet and a width of 15 feet. A grab sample is reported to have assayed 0.3 ounce in gold per ton, and a chip sample across 7 feet taken by the writer returned 0.07 ounce.

The two pits are marked on Map 2408, back pocket. An examination by the author of samples at these pits indicates that pyrrhotite, pyrite, arsenopyrite, and chalcopyrite are interbanded with fine-grained quartz, probably originally chert, and that the rock type is fundamentally similar to that in the Chimo Occurrence (1). A grab sample collected by the author from one of the pits, and analyzed by the Geoscience Laboratories, Ontario Geological Survey, contained 0.02 percent copper, 0.01 percent nickel, and a trace of gold. Folding of the strata in the neighbourhood of this occurrence is complex, and combined with the low outcrop density makes extrapolation of the extent of the banded sulphide-quartz rock difficult. Based on the assays given by Bateman (1938), a geophysical survey to determine the extent of this rock unit could prove worthwhile.

W. Keefe [1937] (7)

Bateman (1938, p.77) stated:

> A group of claims on the southwest side of South Bay adjoining those of Spirit Lake Gold Mines on the south was staked on behalf of William Keefe of Sioux Lookout. A geophysical survey of part of the property was made in the summer of 1937 by Hans Lundberg, Limited. No mineralized occurrences have been reported.

A. Kostynuk [1969] (8)

In 1968, A. Kostynuk staked 12 claims in an L-shaped group just west and south of Opwagan Lake. In 1969 a trench 68.6 m by 0.9 m by 1.5 m, not marked on the map (Map 2408, back pocket) was excavated in conglomerate on one of the claims; no mineralization was found and the claims were allowed to lapse.

Madsen Occurrence (9)

In January and February of 1969, Madsen Red Lake Gold Mines Limited carried out magnetic and electromagnetic surveys of a group of 30 claims whose eastern boundary was located about 1.5 km west of the northwestern end of

Makataiamik Lake. Four main magnetic highs and eight electromagnetic conductors or sets of conductors were located by the surveys (Resident Geologist's Files, Red Lake). In 1970, five diamond-drill holes totalling 176.5 m were put down to test some of the geophysical anomalies.

The geology of the claim group can be seen from Map 2408, back pocket. Outcrop is not plentiful. The southeastern part of the claim group is underlain by metasediments, the southwestern part by intermediate to felsic metavolcanics. Three of the diamond-drill holes were drilled on one claim about 2.5 km west-northwest of the western end of Makataiamik Lake. The two remaining diamond-drill holes (not marked on map) were drilled equally spaced between the first three and the northwest end of the claim group located near the southern end of the half moon-shaped lake, south-southeast of Opwagan Lake. All of the diamond-drill holes were drilled through metasediments. There are several surface expressions of sulphide mineralization on the claim group. About 2.4 km west-northwest of the western end of Makataiamik Lake there is a conglomerate composed of mafic and ultramafic rock fragments (Photo 8). The author identified chalcopyrite, magnetite, and malachite on the outcrop. A grab sample collected by the author and analyzed by the Geoscience Laboratories, Ontario Geological Survey, contained 0.95 percent copper and 0.08 percent nickel. There are three trenches on the outcrop, and these are indicated on Map 2408 (back pocket). The most northerly trench is rather irregular in shape, but is about 20 m long, 0.6 to 0.9 m wide and up to 1.8 m deep. The most southerly trench is about 3.7 m long by 0.5 m wide, and 0.3 to 0.6 m deep. The middle trench is about 9 m long, 0.6 to 0.9 m wide, and up to 0.9 m deep. Unfortunately no data is present in the Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake, on these trenches. Three diamond-drill holes are located near this outcrop.

West of the outcrop just described, there is a sequence of conglomerate, sandstone, intermediate to felsic metavolcanics and intermediate intrusive rocks. All of these rock types contain disseminated sulphides, mostly pyrite and pyrrhotite, although occasionally arsenopyrite and chalcopyrite form up to several percent. Two samples, from different outcrops of the metavolcanics collected by the field party and analyzed by the Geoscience Laboratories, Ontario Geological Survey, contained between 0.1 percent and 0.01 percent chromium, copper, lead, and nickel. About 0.8 km north-northwest of the first outcrop described in this section, there is an outcrop of a white coarse-grained siliceous gritty sandstone, located 2.8 km northwest of the western end of Makataiamik Lake, which contains up to 5 percent pyrite with minor chalcopyrite and pyrrhotite. A grab sample collected by a field party member contains between 0.01 and 0.10 percent chromium, copper, nickel, titanium, and vanadium, and between 0.05 and 0.50 percent manganese. There are two trenches, one 3 m long and the other 7.6 m long, and one diamond-drill hole (Plunge N80°W, dip 40°) on this outcrop.

Drill logs of the first three diamond-drill holes indicate that conglomerate was the host rock, and that minor amounts of pyrite, chalcopyrite, and arsenopyrite, described as being in "streaks and specks" were present (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake). Although sulphides are apparently distributed throughout the length of all three diamond-drill holes, no major sulphide intersections were made. No assay results were given (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake).

The fourth diamond-drill hole was drilled through "quartzite" and "schist". The first 7.6 m of core contained between 2 and 5 percent disseminated sulphides, mostly pyrite and pyrrhotite with minor specks of chalcopyrite and arsenopyrite. The next 12 m contained several 5 to 7.6 cm thick veins of sulphides, pyrite and pyrrhotite as well as disseminated sulphides (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake). The fifth diamond-drill hole indicated several sedimentary rock types including "quartzite", "conglomerate", "slate", and material the author interprets to be sulphide-facies iron formation. Although disseminated pyrite, pyrrhotite, chalcopyrite, and arsenopyrite are present, the best sulphide intersections are composed of banded sulphides, for example:

> ...90.7 feet to 96.0 feet heavy near massive, crystalline banded sulphide, mainly pyrrhotite (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake).

The exploration work carried out by Madsen Red Lake Gold Mines Limited has indicated that there is sulphide mineralization in the rocks underlying the claim group. There is potential for copper and possibly nickel mineralization, and perhaps gold if the arsenopyrite-gold association of the North Spirit Lake area holds true (Wood 1977).

McDonald Occurrence (10)

In 1957 three diamond-drill holes totalling 88.3 m in length were drilled on the 18 claim group of A.H. McDonald. The eastern part of the claim group included the small pear-shaped lake some 4 km south of Makataiamik Lake. The mineral occurrence of interest lies about 360 m west of the small lake and is located in sheared metasediments adjacent to the contact with a diorite sill which constitutes the western part of the northward sloping outcrop area. The direction of shearing is towards the north-northwest, the shear-zone may be part of, or related to, the Roseberry River Fault indicated on Map 2408, back pocket. Metasediments include black fine-grained argillaceous rocks possibly originally black shales and para-amphibolite; the original nature of a siliceous rock type is not known, possible progenitors could be a siliceous sandstone, or an iron formation. The outcrop area of the metasediments has been extensively blasted, and three pits cover most of the outcrop area. All of the pits have their long dimension oriented east-west; the largest pit is the most northerly and is 7.6 m long by 3.7 m wide. The other two pits lie almost side by side to the south of the first, and are 3.7 m long by 12 m wide, and 3.7 m long and 1.8 m wide respectively. The depth of any one pit is variable, the maximum apparent depth of the largest pit is approximately 1.8 m, and in the smaller pits, about 0.6 to 0.9 m. Just to the south of the outcrop area, a fourth pit oriented parallel to the others is 4.6 by 1.5 by 0.6 m in dimensions. Pyrrhotite, pyrite, sphalerite, and galena were identified in outcrop by the author. All of the sulphides are fine grained and occur in small pods and veinlets.

Drill logs of the 1957 diamond-drill holes indicate that pyrite was present in drill core samples and traces of copper and nickel were found by assay (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake). In early 1968, D. Doal staked 40 claims which included ground previously held by McDonald (Mining Recorder's Files, Ontario Ministry of Natural Resources, Red Lake). In April and May of 1968 Scurry-Rainbow Oil Limited, Mining Division, drilled four short diamond-drill holes, totalling 64.7 m by "packsack" drill. Three of these diamond-drill holes were located on the original occurrence, the fourth 100 m to the south and west (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake). Drill logs of three of the diamond-drill holes indicate bedrock is "gabbro" and "metavolcanics"; and pyrrhotite, pyrite, arsenopyrite, sphalerite, galena, and chalcopyrite are present. The diamond-drill log of the fourth hole indicates a complex of metavolcanics and siliceous material with pyrite, pyrrhotite, sphalerite, and chalcopyrite, present in veinlets and disseminated in the host rocks (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake). Assay results quoted in the diamond-drill logs indicate high silver content as follows: 3.72 ounces of silver per ton and 0.01 ounce of gold per ton over 0.6 m, 1.94 ounces of silver per ton and 0.02 ounce of gold per ton over 0.4 m; and also indicate the presence of copper, lead, and zinc.

In 1969, the Doal claim group was included in airborne magnetic and electromagnetic surveys by Questor International on behalf of Noranda Exploration Company Limited (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake). Several six-channel anomalies were discovered on the claim group, three of these were located on the claim containing the McDonald Occurrence (10). Two diamond-drill holes were drilled for a total length of 157.6 m, one was abandoned because of bad ground at 43.9 m on the outcrop described above. Another diamond-drill hole 299 m in length was drilled some 790 m to the northwest presumably to test an airborne electromagnetic anomaly, since there is no outcrop nearby and an anomaly is present (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake). The two diamond-drill holes on the original occurrence indicate that rock types underlying the northeast part of the outcrop area are predominantly argillite, amphibolite, argillite-quartzite, argillite-conglomerate, and banded magnetite iron formation, patches of pyrite, and galena and sphalerite, were noted in the drill logs. A 1.5 m length of core is reported to have yielded an assay of 0.90 ounce of silver per ton (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake). The third diamond-drill hole indicated that the rock types were: argillite, basalt, quartzite, garnetiferous amphibolite, greywacke, conglomerate; traces of pyrite, pyrrhotite, and chalcopyrite, and patches of pyrite and pyrrhotite sometimes in massive form (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake) were reported. No assay results were given.

This occurrence is of interest because of the sulphide mineralization visible on surface and in diamond drill-core. However, because of the low outcrop density considerable amounts of diamond-drilling would be a necessity in any exploration programme.

Noranda Exploration Company Limited (11, 12, 13, 14, and 15)

During 1969 and 1970, the company was active in four separate locations within the map-area. The work done on one of these locations, north of the "V" in Hewitt Lake, partly overlapping the claim group previously held by Chimo Gold Mines Limited has already been discussed in the section Chimo Occurrence (1, 11). Most of the work on another claim group, near the northern boundary of the map-area, northeast of Margot Lake, was performed outside of the map-area and is discussed in a geological report on the North Spirit Lake area (Wood 1977). This claim group will, therefore, be referred to as "North Spirit Lake [1970] (14)". Another claim group on which Noranda Exploration Company Limited did mineral exploration was located to the northwest of Wokokotai Lake after which the claim group is named in this report (Wokokotai Lake [1969] (15)). The fourth claim group on which this company has worked is located in the eastern part of the map-area. Much of the work performed on this latter group is discussed in other sections of this report, see "McDonald Occurrence (10)" and "Scurry Rainbow Occurrence (16)". The individual who staked many of the claims in this group (Mining Recorder's Files, Ontario Ministry of Natural Resources, Red Lake) and who held that part of the claim group on which the only occurrence so far not described is G. Desmeules; this claim group is therefore entitled "Noranda Exploration Company Limited, Desmeules Occurrence (12)".

CHIMO OCCURRENCE (11)

The relevant aspects of this occurrence have been discussed in the section on "Chimo Gold Mines Limited Occurrence (1)". The addition of this section is to permit distinction of the relative sizes and locations of the Chimo and Noranda claim groups shown on Figure 14.

DESMEULES OCCURRENCE (12)

The mineral showing which prompted drilling by Noranda Exploration Company Limited and Scurry-Rainbow Oil Limited, Mining Division, is located just to the south of the western end of Makataiamik Lake at the contact of mafic metavolcanics and overlying conglomerate. The mineralization which includes pyrite, magnetite, chalcopyrite, and arsenopyrite, occurs in narrow veins localized by shearing, parallel to the strike of the contact. A trench approximately 15 m by 1.5 m by 0.9 m has been excavated across the contact. Of two grab samples collected from the trench by the author and assayed by the Geoscience Laboratories, Ontario Geological Survey, the more richly mineralized contained 0.06 percent copper and 0.15 percent cobalt. No data exists in the Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake, as to who trenched the outcrop. The 70 claim group on which mineralization is present was staked in 1968 by G. Desmeules (Mining Recorder's Files, Ontario Ministry of Natural Resources, Red Lake). This 70 claim group included also the occurrence referred to here as the Scurry Rainbow Occurrence (16).

In 1968, three diamond-drill holes totalling 58.2 m in length were drilled by Scurry Rainbow Oil, Mining Division, just to the south of the showing (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake). All three diamond-drill holes were in metasediments. Disseminated and semi-massive sulphides, notably pyrrhotite and pyrite with some chalcopyrite were noted in diamond-drill core logs.

In 1969, the Noranda Exploration Company Limited diamond-drilled a north dipping (54°) hole 105.8 m long collared about 100 m to the south of the mineral showing. Diamond-drill core logs in the Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake, indicate that the diamond-drill hole passed through the metasediments and into the metavolcanics (metabasalt). Sulphides, comprising pyrite and pyrrhotite with minor chalcopyrite were encountered principally in the contact zone. The last 60 m of core is reported to have given consistent low copper-nickel values over narrow footages as follows: 0.27 percent copper, and 0.08 percent nickel over 0.76 m; 0.34 percent copper and 0.05 percent nickel over 0.76 m; 0.67 percent copper over 0.9 m. Traces of gold and silver were noted in assay samples throughout the last 60 m length of diamond-drill core (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake).

The electromagnetic anomaly diamond drilled, represents only one of several which form two parallel rows trending parallel to the south shore of Makataiamik Lake, and along the central part of the lake (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake).

MAKATAIAMIK LAKE [1969](13)

In 1969, Noranda Exploration Company Limited had airborne magnetic and electromagnetic surveys carried out on a group of 235 claims in the vicinity of Makataiamik Lake. This claim group consisted of a number of smaller groups, some owned by Noranda Exploration Company Limited, and some owned by individual prospectors. The survey was done by Questor International. Several geophysically anomalous areas were outlined, three were diamond-drilled; two form part of the McDonald Occurrence (10), the third is described in the following section.

NORTH SPIRIT LAKE [1970](14)

Of the 23 claims comprising this group, only two complete claims and parts of seven others lie within the map-area. In 1969, ground electromagnetic and magnetometer surveys were completed as a follow up to airborne geophysical surveys (Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake). In 1970, two diamond-drill holes totalling 292.2 m were drilled on claims outside the map-area. Within the map-area, the claims are underlain by sandstone, with minor conglomerate and siltstone. No surface mineralization was noted. Diamond-drill-core logs indicate that pyrite, pyrrhotite, and traces of chalcopyrite are disseminated and form in patches within the host rock. It is difficult to evaluate the mineral potential of this property based on present knowledge.

WOKOKOTAI LAKE [1969](15)

No assessment work has been filed for this property. The Mining Recorder's Files, Ontario Ministry of Natural Resources, Red Lake, indicate that ownership of a group of 28 claims, which was seven claims east-west by four claims north-south, and had its southeastern corner at the northern tip of Wokokotai Lake, was transferred to Noranda Exploration Company Limited in September, 1969. During field mapping in 1973, diamond-drill core was found at the northern end of Wokokotai Lake. No data exists on this in the Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake. Diamond-drill core left near the lake shore was in part composed of "sulphide facies iron formation". This rock consists of banded quartz-sulphide, mostly massive pyrite and pyrrhotite with traces of chalcopyrite, rock very similar to rocks outcropping on the Chimo Occurrence (1). This banded quartz-sulphide metasedimentary unit is most likely continuous from the occurrence on Hewitt Lake to the north end of Wokokotai Lake. The outcrop density on the claim group is very low, most of the group is covered by swamp and muskeg with only a few outcrops in the southeastern corner; there, the rock types include clastic metasediments (from pebble conglomerate to siltstone) and a suite of igneous rocks of intermediate composition, either pyroclastic crystal tuff or high-level intrusions, or a complex of both.

SCURRY RAINBOW OCCURRENCE(16)

This occurrence is located south of the western end of Makataiamik Lake and consists of several arsenopyrite-fuchsite-tourmaline veins in a clastic metasedimentary sequence composed predominantly of sandstone with minor cobble and granule conglomerate. The mineralization is located on the same claim group as the Desmeules Occurrence (12). The largest vein visible trends at approximately 20° east of north, and dips steeply, and was probably in excess of 15 m long and 1.2 m wide; extensive blasting has removed most of the original features of the outcrop areas. The metasediments strike at about 100°. There are at least four pits and one trench within an area of 100 m^2. The pits are all small, and rarely exceed 1.8 m by 1.8 m. The trench is 13.7 m long and 1.2 m wide. Quartz veins about 0.3 m wide and trending approximately parallel to the strike were noted; the relationship of these to the arsenopyrite veins was not readily apparent. A rock type identified in the field as a muscovite-garnet pegmatite was also noted. In one of the pits, the metasediments were sheared, the shearing having a trend of S40°E. Galena was identified in the metasediments and did not appear to be directly related to the arsenopyrite-bearing veins based on evidence from the blasted outcrops. A grab sample collected by the author from the largest vein and assayed by the Geoscience Laboratories, Ontario Geological Survey, contained 0.05 ounce of gold per ton, and 0.40 percent lead.

Scurry-Rainbow Oil Limited, Mining Division, in 1968, diamond drilled two holes totalling 19.8 m in length. Minor pyrite, pyrrhotite, galena, arsenopyrite, and sphalerite are noted in the diamond-drill logs. The potential of this occurrence is dependent on the concentration of sulphide-bearing veins.

SUGGESTIONS FOR MINERAL EXPLORATION

Data filed in the Resident Geologist's Files, Ontario Ministry of Natural Resources, Red Lake indicate that past mineral exploration in the Hewitt Lake area has not been extensive. Based on presently available data such as field work, assessment work, and geological concepts concerning economic mineralization, such as those expressed by R.W. Hutchinson, R.H. Ridler, and G.G. Suffel (1971), several recommendations can be made as follows:

There are four primary exploration targets, these are:

a) The ultramafic rocks;
b) The felsic to intermediate metavolcanics, and subvolcanic intrusions;
c) The chemical metasediments;
d) The granitic rocks.

The potential for copper-nickel mineralization in the ultramafic rocks must be high. The conglomerate on the Madsen Red Lake Mines Limited occurrence returned the best assay results from the map-area. There can be little doubt that the copper-nickel minerals, like some of the rock components, were derived from the ultramafic rocks to the northeast. The only potentially negative aspect of the conglomerate mineralization is that it may represent destruction by erosion of a pre-existing ore body in the ultramafic rocks. The possibility of further mineralization in the ultramafics both in the northeastern part and other parts of the map-area should not be disregarded.

Siliceous metavolcanics are highly regarded by exploration geologists as hosts for copper-zinc mineralization. Examples of this geological environment are the Kidd Creek Mine near Timmins and the Mattabi Mine near Ignace. The wide belt of felsic to intermediate metavolcanics between the South Bay of North Spirit Lake and the Roseberry River, the northwest flowing part, is worthy of detailed study based on the occurrences of disseminated sulphides in the rocks and on certain metallogenetic concepts. Other similar lithofacies in the map-area should be regarded in a similar light.

Two large possible subvolcanic intrusions in the map-area are the Wokokotai Lake body and the Makataiamik Lake Stock. Both contain small amounts of disseminated pyrite and could hold potential as hosts for other sulphide mineralization.

Chemical metasediments are such as the extensive iron formation just to the north of the Hewitt Lake area in the vicinity of Wapisipi Lake offer potential for other minerals. Gold in particular has been proven to be present in at least some of the siliceous chemical metasediments in the map-area. The chemical siliceous metasediments should be examined with a view to discovering gold mineralization.

The clastic metasediments within the map-area are regarded as being immature by the author, they may consequently have acted as a dispersal rather than a concentrating mechanism. In a paleographic situation where clastic metasediments may have been subjected to processes of volcanic activity, such as the exhalite process the clastic metasediments attain the same mineral potential as metavolcanics.

The granitic rocks, although not studied in detail in this report, offer potential for economic mineralization. Molybdenite was found south of the eastern end of Makataiamik Lake, and the potential of discovering porphyry deposits of copper or molybdenum should be considered.

REFERENCES

Arndt, N.T.

1975: Ultramafic Rocks of Munro Township and Their Volcanic Setting; Unpublished Ph.D. Thesis, Univ. of Toronto, 192p.

Ayres, L.D.

1971: Northwind Lake Area, District of Kenora (Patricia Portion); p. 3-9 *in* Summary of Field Work, 1971 by the Geological Branch, Edited by E.G. Pye, Ontario Department of Mines and Northern Affairs, MP49, 109p.

1972: Guide to Granitic Rock Nomenclature Used in Reports of the Ontario Division of Mines; Ontario Division of Mines, MP52, 14p.

Ayres, L.D., Lumbers, S.B., Milne, V.G., and Robeson, D.W.

1970: Ontario Geological Map, East Central Sheet; Ontario Department of Mines and Northern Affairs, Map 2198, scale 1 inch to 16 miles. Compilation 1970.

Ayres, L.D., and Raudsepp, M.

1970: Favourable Lake-Poplar Hill Area, District of Kenora (Patricia Portion); p. 7-12 *in* Summary of field work, 1970 by the Geological Branch, Edited by E.G. Pye, Ontario Department of Mines and Northern Affairs, MP43, 96p.

Ayres, L.D., Raudsepp, M.,Averill, S.A., and Edwards, G.R.

1972: Geological Compilation of the Favourable Lake-Berens Lake Area, Ontario; Ontario Division of Mines, Map 2262, Geological Compilation Series.

Barrow, G.

1893: On An Intrusion of Muscovite-Biotite Gneiss in the Southeast Highlands of Scotland, and Its Accompanying Metamorphism; Quarterly Journal of the Geological Society of London, Volume 49, p.330-358.

1912: On the Geology of Lower Dee-side and the Southern Highland Border; Geological Association Proceedings, Volume 23, p.274-290.

Bateman, J.D.

1938: Geology of the North Spirit Lake Area; Ontario Department of Mines, Volume 47, Part 7, p.44-78 (published 1939). Accompanied by Map 47G, scale 1 inch to 1 mile.

Bouma, A.H.

1962: Sedimentology of Some Flysch Deposits; Elsevier, Amsterdam, 168p.

Cummins, W.A.

1962: The Greywacke Problem; Liverpool and Manchester Geological Journal, Volume 3, p.51-72.

Donaldson, J.A.

1961: Geology, North Spirit Lake, Ontario; Geological Survey of Canada, Map 50-1960, Preliminary Series. Scale 1 inch to 4 miles.

1969: Geology, North Spirit Lake, Ontario; Geological Survey of Canada, Map 1201A, "A" Series. Scale 1 inch to 4 miles.

Donaldson, J.A., Jackson, G.D.

1965: Archean Sedimentary Rocks of the North Spirit Lake Area, Northwestern Ontario; Canadian Journal of Earth Sciences, Volume 2, p.622-47.

Fisher, R.V.

1965: Rocks Composed of Volcanic Fragments and Their Classification; Earth-Science Review, Volume 1, p.287-298.

Giblin, P.E., and Leahy, E.J.
1967: Sault Ste. Marie-Elliot Lake Sheet, Algoma, Manitoulin, and Sudbury Districts; Ontario Department of Mines, Geological Compilation Series, Map 2108, scale 1 inch to 4 miles. Geological Compilation 1964-1965.

Gibson, H.L.
1976: Komatiitic Rocks of the North Spirit Lake Area, Northwestern Ontario; Unpublished B.Sc. Thesis, Queen's University, Kingston, 109p.

Hatch, F.H., Wells, A.K. and Wells, M.K.
1972: Petrology of the Igneous Rocks, 13th Edition; Thomas Murby and Co., London, 551p.

Hurst, M.E.
1929: Geology of the Area Between Favourable Lake and Sandy Lake, District of Kenora (Patricia Portion); Ontario Department of Mines, Volume 38, Part 2, p.49-84 (published 1930). Accompanied by Map 38a, Scale 1 inch to 2 miles.

Hutchinson, R.W., Ridler, R.H., and Suffel, G.G.
1971: Metallogenic Relationships in the Abitibi Belt, Canada; A Model for Archean Metallogeny; Canadian Institute of Mining and Metallurgy, Transactions, Volume 74, Vol. 74, p.106-115.

Hyndman, D.W.
1972: Petrology of Igneous and Metamorphic Rocks; McGraw-Hill, 533p.

Johnson, M.R.W.
1962: Relations of Movement and Metamorphism in the Dalradian of Banffshire; Transactions of the Geological Society of Edinburgh, Volume 19, p.29-64.

Krauskopf, K.B.
1967: Introduction to Geochemistry; McGraw-Hill, New York, 721p.

McBride, E.G.
1963: A Classification of Sandstones; Journal of Sedimentary Petrology, Volume 33, p.664-669.

Miyashiro, A.
1961: Evolution of Metamorphic Belts; Journal of Petrology, Volume 2, p.277-311.

Naldrett, A.J.
1973: Nickel Sulphide Deposits - Their Classification and Genesis with Special Emphasis on Deposits of Volcanic Association; Canadian Institute of Mining Transactions; Volume 76, p.182-201.

Nesbitt, R.W.
1971: Skeletal Crystal Forms in the Ultramafic Rocks of the Yilgarn Block, Western Australia; Evidence for an Archean Ultramafic Liquid; Geological Society of Australia Special, Publication No.3, p. 331-347.

ODM-GSC
1960a: Hewitt Lake Sheet, District of Kenora (Patricia Portion), Ontario; Ontario Department of Mines-Geological Survey of Canada, Aeromagnetic Map 877G, scale 1 inch to 1 mile.
1960b: Margot Lake Sheet, District of Kenora (Patricia Portion), Ontario; Ontario Department of Mines, Geological Survey of Canada, Aeromagnetic Map 867G, scale 1 inch to 1 mile.
1963: North Spirit Lake Sheet, District of Kenora (Patricia Portion), Ontario; Ontario Department of Mines-Geological Survey of Canada, Aeromagnetic Map 7012G, scale 1:253 440.

Pettijohn, F.J.
1957: Sedimentary Rocks; Harper, 718p.

Pettijohn, F.J., Potter, P.E., and Siever, R.
1972: Sand and Sandstone; Springer Verlag, 618p.

Prest, V.K.
1963: Red Lake-Landsdowne House Area, Northwestern Ontario, Surficial Geology; Geological Survey of Canada, Paper 63-6, 23p.

Pyke, D.R., Naldrett, A.J., and Eckstrand, O.R.
1973: Archean Ultramafic Flows in Munro Township, Ontario; Geological Society of America Bulletin, Volume 89, p. 955-978.

Read, H.H.
1952: Metamorphism and Magmatism in the Ythan Valley, Aberdeenshire; Transactions of the Geological Society Edinburgh, Volume 15, p.265-279.

Robertson, J.A., Giblin, P.E., and Leahy, E.J.
1971: Blind River-Elliot Lake Sheet, Algoma and Sudbury Districts; Ontario Department of Mines and Northern Affairs, Geological Compilation Series, Preliminary Map P.304 (1971 Revision), scale 1 inch to 2 miles. Geological Compilation Giblin and Leahy 1967, Robertson 1971.

Shaw, D.M.
1957: Some Recommendations Regarding Metamorphic Nomenclature; Proceedings of the Geological Association of Canada, Volume 9, p. 68-81.

Sutton, J.
1965: Some Recent Advances in Our Understanding of the Controls of Metamorphism; p.22-45 *in* Controls of Metamorphism, Edited by W.S. Pitcher and G.W. Flinn, Wiley, New York.

Turner, F.J., and Verhoogen, J.
1960: Igneous and Metamorphic Petrology, Second Edition; McGraw-Hill, 694p.

Viljoen, J.M., and Viljoen, R.P.
1969: The Geology and Geochemistry of the Lower Ultramafic Unit of the Onverwacht Group and a Proposed New Class of Igneous Rock; Geological Society of South Africa, Special Publication Number 2, p.55-85.

Walker, R.G.
1975: Generalized Facies Models for Resedimented Conglomerates of Turbidite Association; Geological Society of America Bulletin, Volume 86, p.737-748.

Wentworth, C.
1922: A Scale of Grade and Class Terms for Clastic Sediments; Journal of Geology, Volume 30, p.377-92.

Williams, H., Turner, F.J., and Gilbert, C.M.
1954: Petrology; Freeman, San Francisco, 406p.

Winkler, H.G.F.
1967: Petrogenesis of Metamorphic Rocks; Second Revised Edition, Springer-Verlag, 237p.

Wood, J.
1971: Geology of the Rawhide Lake Area; Ontario Division of Mines, GR129, 67p.
1972a: North Spirit Lake Area (Western Part), District of Kenora, Patricia Portion; Ontario Division of Mines, Preliminary Map P.759, Geological Series, scale 1 inch to ¼ mile.

1972b: North Spirit Lake Area (Eastern Part), District of Kenora, Patricia Portion; Ontario Division of Mines, Preliminary Map P.760, Geological Series, scale 1 inch to ¼ mile.

1972c: Hewitt Lake Area (Western Half), District of Kenora (Patricia Portion); Ontario Division of Mines, Preliminary Map P.795, Geological Series, scale 1 inch to ¼ mile.

1977: Geology of the North Spirit Lake Area, District of Kenora, (Patricia Portion); Ontario Division of Mines, GR150, 60p. Accompanied by Map 2362, scale 1 inch to ½ mile (1:31 680).

Wood, J., and Hunter, A.D.

1974: Hewitt Lake Area (Eastern Half), District of Kenora (Patricia Portion); Ontario Division of Mines, Preliminary Map P.940, Geological Series, scale 1 inch to ¼ mile.

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